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FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIII

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT - DIRECTOR
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST
OUTLINE MAP OF CALIFORNIA
SCALE
OREGON
NEVADA
MEXICO
PACIFIC OCEAN
SISKIYOU
MODOC
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
GLENN
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SANTA CLARA
MERCED
SANTA CRUZ
SAN BENITO
MADERA
INYO
MONTEREY
FRESNO
VISALIA
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
LEGEND
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered, consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geological Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g. feldspar).

3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

Conejo Oil Field, Ventura County. Shallow wells (100 ft. to 300 ft.) pumped by jacks and cables.
Photo by Walter W. Bradley.

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District. Mr. Chas. V. Averill, District Mining Engineer, is engaged on investigations for a new report upon the mines and mineral resources of Plumas County. This will be accompanied by a new geologic map of the county.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

Reports covering the mines and mineral resources of most of the counties in the Los Angeles field division are now available, and field work at present is confined to investigations for special reports upon Inyo, Mono and Los Angeles counties.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

Three large and comprehensive undertakings by the Geologic Branch are nearing completion:

(1) Bibliography of the Geology and Mineral Resources of California for the years 1931-1936, inclusive, with subject index: In preparation under the supervision of Dr. Solon Shedd, Department of Geology, Stanford University. This will be a companion-piece to Bulletin 104 which includes all references to the State's geology and related subjects prior to 1931. The manuscript is nearly ready for the press.

(2) Minerals of California, a revision of Bulletin 91: In preparation under the direction of Dr. Adolf Pabst, Professor of Mineralogy of the University of California, and successor of the late Dr. A. S. Eakle who prepared the earlier Bulletin No. 91, published by the California State Mining Bureau in 1923. The manuscript with index will probably be ready for the printer before the middle of this year.

(3) First preliminary issue (in 6 sections) of the State Geologic Map of California, scale 1:500,000, is now about ready for the lithographer. In the article which follows, the principal source data are given which have been consulted (prior to January, 1937) in the preparation of this map. It is planned that in this edition, though the geologic formations are not to be designated in the usual color-patterns, their boundaries and unit symbols will be clearly shown.

It is further planned, in later issues of the state geologic map, to show all the principal mineral deposits of California located in due respect to the areal distribution of the geologic formations. This information is now being plotted by the Geologic Branch.

SOURCE DATA OF THE GEOLOGIC MAP OF CALIFORNIA, JANUARY 1937

By Olaf P. Jenkins, Chief Geologist

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INTRODUCTION

The first preliminary issue of the geologic map of California (scale 1: 500,000) is now ready for the press. It represents the result of 8 years of careful coordination of geological research, which has extended over a period of as many decades. Before the final colored map is published (the present map is to show geologic boundaries without the usual colors or patterns), it is hoped that any imperfections in this preliminary issue will be corrected, and that further detailed field work will be done to fill the areas now left blank or in need of more accurate mapping; these represent over 25 per cent of the state. The principal sources, forming the basis of the map up to January, 1937, are presented in the following list of references.

Accompanying this list is an index map showing the areas covered by each detailed source map of any appreciable size actually transcribed during the compilation. Each area bears an index symbol indicating the initial of the author and the year of publication. The symbol is repeated in front of the corresponding reference in the list. Miscellaneous sources and confidential records are marked with the letter "X." As further means of identification of the sources, a five-fold classification has been made as follows: (1) U. S. Geological Survey publications. (2) University of California publications. (3) State publications other than those of the University of California. (4) Publications other than state and federal. (5) Unpublished sources.

The references in the list which are not shown on the index map have been very useful in the compilation, though not in every case have the maps that accompany them been transcribed directly to the large map. For the most part, reports lacking geologic maps or dealing only with stratigraphy, structure, economic geology, etc., have been omitted from the list. These as well as other reports on the geology

of California will be found in Bulletin 104,[1] which was prepared partly as an outgrowth of the state map work.

Though many unpublished reports and maps were examined and used, only a portion of these (such as university graduate theses) is actually listed. The others represent confidential reports of private individuals or of geological departments of oil companies and other commercial concerns.

The numerous contributors have been exceedingly generous. If some have been omitted from this list it is either because of the desire of the contributor or an oversight on the part of the writer. It is the writer's desire, however, that this list of sources be made as complete as possible. Needless to say, the state geologic map would not have attained its present approach to completion if unpublished maps had not been so generously given to the undertaking.

PREVIOUS STATE GEOLOGIC MAPS[2]

One of the first attempts to prepare a geologic map of California was made from 1854-1875 by Jules Marcou, who was employed by the United States government on the expedition of Lieutenant Whipple. Marcou's map,[3] only one page in size, shows in colors six geologic units, and some of the major features of the Sierra Nevada and southern Coast Ranges. It was published in 1883.

In 1872 Charles H. Hitchcock with the assistance of William P. Blake published a colored lithograph geologic map of the United States.[4] The part covered by California was "Compiled by W. P. Blake, from personal observations; Pacific Railroad reports, both for United States and railroad corporations; California reports, by J. D. Whitney; geology of 40th parallel, by Clarence King, and other sources."[5]

Bibliographic record shows that in 1873 Josiah Dwight Whitney (the second state geologist) prepared a geologic map of the State of California on the scale of 36 miles to one inch. It was, however, never published.

In 1891 the California State Mining Bureau issued its first geologic map[6] of the state, showing 9 cartographic units. In the Tenth Annual Report, the State Mineralogist, Wm. Irelan, Jr., says: "H. I. Willey, ex-State Surveyor General, was engineer in charge of the Preliminary Geological and Mineralogical map, the topographical and other work thereon being executed by Mr. Julius Henkenius, who received aid in the geological and mineralogical locatings from the Field Assistants." The report shows the names of several well-known geologists and engineers. Harold W. Fairbanks, W. A. Goodyear, and W. L. Watts are

[1] Shedd, Solon—Bibliography of the geology and mineral resources of California to December 31, 1930; Cal. State Div. Mines, Bull. 104, 1932. Supplemental bibliography, 1931-1936, inclusive, nearly ready for the press.

[2] See also Vogdes, Anthony W.—A bibliography relating to the geology, paleontology, and mineral resources of California: Cal. State Min. Bur., Bull. 30, 1904. Cartography of California: Part VI, pp. 175-258.

[3] Marcou, Jules—Carte geologique de la Californie par Jules Marcou, 1854-1875: Bull. Soc. Geol. France, 3rd ser. vol. 11, Plate XI, 1883.

[4] Ninth Census, 1872; also Raymond report of 1873.

[5] Raymond, Rossiter W.—Statistics of mines and mining in the states and territories west of the Rocky Mountains: 5th An. Rept. Raymond, 42nd Congress, 3rd Session, Ex. Doc. 210, 1873, pp. 480-484.

[6] Irelan, Wm., Jr.—Preliminary mineralogical and geological map of State of California: Cal. State Min. Bur., Jan. 1, 1891. Scale 1" = 12 mi. Drawn by J. C. Henkenius. See also the 10th An. Rept. of the State Mineralogist (1890), p. 21.

among the "assistants"; while Ross E. Browne and John Hays Hammond were apparently consulting mining engineers. Thus very able men must have contributed to the making of this state map.

A quarter of a century later the California State Mining Bureau published its second state geologic map,[7] prepared by James Perrin Smith, Professor of Paleontology at Stanford University. This map was drawn on the same scale as the previous map, *i.e.,* 12 miles to one inch, but it was a long stride in advance; 21 cartographic units show in colors the distribution of the rocks of all of the major geologic periods represented in the state. It was accompanied by a brief report[8] which included detailed stratigraphic columns and correlation tables summarizing in excellent manner the geologic history of California. In the introduction to this bulletin J. P. Smith says:

"The State Mineralogist, Mr. Fletcher Hamilton, was resolved to signalize the end of the second quarter of a century of studies in the geology of California by taking stock, and showing what we have done in that period. The writer agreed, at his request, to sum up all available information in map form."

In a report on the "Springs of California,"[9] published by the U. S. Geological Survey in 1915, a "Lithologic Map of California," scale 1:2,000,000, compiled by Gerald A. Waring in 1914, appeared in the same year as the geologic map by J. P. Smith. Though not issued as a state geologic map, Waring's compilation shows the distribution of the principal geologic groups throughout the state in considerably more detail than the geologic map of 1891.

THE NEW STATE GEOLOGIC MAP

In the preparation of the J. P. Smith map, members of his classes participated in the compilation; the present writer was one of those students who worked on the map in 1911 and 1912. Now, another quarter of a century has nearly passed and the state is again taking stock of the vast amount of geological information which has since accumulated. This new plotting, however, is being done on a map of much larger scale; therefore, the work is in considerably more detail, and geologic boundary lines are drawn with much greater precision.

The new map is on the scale of approximately eight miles to one inch, and shows 81 cartographic units; it also shows the principal fault lines, so far as they have actually been mapped. An attempt has been made to leave off the more questionable data and to draw in geologic boundaries only where they have been mapped with considerable care on other bases of larger scale.

The desire to have such a map constructed has been almost universal. The mineral committees of the California State Chamber of

[7] Smith, James Perrin—Geological map of the State of California, scale 1" = 12 mi.: Cal. State Min. Bur. 1916, reprinted in 1929.

[8] Smith, James Perrin—The geologic formations of California, with reconnaissance geologic map: Cal. State Min. Bur. Bull. 72, 1916, 47 pp.

[9] Waring, Gerald A.—Springs of California; U. S. Geol. Survey, Water-Supply Paper 338 (1915). Plate II—Lithologic map of California, scale 1:2,000,000, compiled by G. A. Waring, 1914, shows 5 cartographic units in colors.. "Note: The rock distribution has been compiled from published and unpublished data of the U. S. Geological Survey and from the geologic map of California issued by the State Mining Bureau in 1891."

Commerce and the Commonwealth Club of California, together with other organizations, demanded that the work be done. Assemblage of information and synchronization of the geologic knowledge of California has been especially needed. A ten-year program[10] was tentatively planned in 1929 with the assumption that adequate state appropriations would be granted to cover it. Unfortunately, only limited appropriations were forthcoming. In spite of this fact, through the splendid cooperation of geologists in various fields, and the persistence of those persons in charge of the work, a very fine map has resulted.

It has been particularly fortunate for the work that much private information, hitherto withheld from publication, has been released. When the work was started in 1929, the U. S. Geological Survey was desirous of cooperation, since it had undertaken the task of making a new geologic map of the entire United States for the 16th International Geological Congress. Cooperation was, therefore, duly arranged with the Federal Survey whose map was first compiled on the scale of 1 : 500,000, the scale that has been adopted for the present map. The U. S. Geological Survey's map was compiled in Washington, under the direction of George W. Stose, Geologic Map Editor, from all available sources, including manuscript maps in the Survey office and others obtained by Stose from geologists in California, and data that were assembled by the writer in San Francisco and sent to Washington. The correlation and adjustment of the map units of the various authors and the assembling of a comprehensive legend were done by Stose with the cooperation of the writer. The base had already been prepared and published by the U. S. Geological Survey, and the geology was drawn on that base.

This Stose-Jenkins map was not published and was not intended for publication by the Geological Survey on its original scale; but an area covering the northern Sierra Nevada,[11] for the most part traced from this map with minor modifications and the addition of economic features, including the Tertiary channels, was issued by the State Division of Mines in 1932. The geologic map of the United States,[12] however, was published, as planned, by the U. S. Geological Survey in 1932, the part covered by the compiled geologic map of California being transcribed in a somewhat generalized form for this much smaller scale, i. e., about 40 miles to one inch. But the original compilation with its legend was made available by the Federal Survey to the State Division for use in the compilation of the present map and has been invaluable for the purpose.

So much new information was secured in the meantime and so much better conception was achieved of how the map should be made, that it was decided to completely redraw the entire map embodying in it the accumulating new material. The legend prepared for the original compilation with minor changes was, however, found adequate for the new

[10] Suggestion by Mr. T. J. Hoover, then Dean of the School of Engineering, Stanford University, to the Section of Mineral Resources, Commonwealth Club of California, October 30, 1929.

[11] Jenkins, Olaf P.—Report accompanying geologic map of northern Sierra Nevada: State Mineralogist's Rept. 28, 1932, pp. 279-298. (Geologic map of northern Sierra Nevada showing Tertiary river channels and Mother Lode belt. Scale 1" = 8 mi.)

[12] Stose, George W., and Ljungstedt, O. A.—Geologic map of the United States, scale 1:2,500,000: U. S. Geol. Survey, 1932, 16th International Geol. Congress.

compilation. A small appropriation from the Public Works Administration was later secured and deposited with the U. S. Geological Survey. From this fund the salaries of two geological draftsmen were paid for a period of one and one-half years. As the result, the map was completely recompiled and redrawn. This work was done under the direct supervision of the writer in rooms provided by the Department of Geology at Stanford University.

The method employed in compilation has been as follows:

(1) Evaluation of source to be used; preferably compiling first the latest and most detailed. (2) Determination of cartographic units to be employed on the new map. (3) Tracing from the original scale only the geologic boundaries needed for the new map, together with control lines, such as townships and meridians. (4) Photographic reduction of detailed maps to scale of the new map. (5) Tracing of reduced copy on cloth of base map. (6) Recording and filing of data by means of (a) correlation charts, (b) index map, (c) card index, (d) general depository for the maps and notes used. Many field excursions have been made by the writer and many geologists interviewed. In a state as large as California (158,297 square miles) and with as much diversified complex geology, an unlimited amount of field work will be necessary to complete the present map even in a general way.

In the preparation of the redrawn map most of the photographic reduction, the transcribing, and drafting was done by Burt Beverly. The task of compiling the complex geology of the Coast Range is largely the work of E. Wayne Galliher, who also contributed some field work. Several other assistants have since helped in the tasks of drafting, filing, and bibliographic work. The sheets now ready for the lithographer have again been redrawn in a manner suitable for reproduction.

The publication of Reed's "Geology of California"[13] has proved very helpful indeed. So also has Wilmarth's "Geologic Units of California."[14]

The new state map in progress form has been exhibited at various geological meetings and has been examined and criticized by a large number of geologists. It still remains a map in progress and should always serve as a general clearing house for geologic information on California.

UNMAPPED AREAS

For the most part, areas which have not been geologically surveyed in a manner accurate enough to show on the new state map have purposely been left blank.

Throughout most of the mapped areas which appear fully covered, there are small patches which are still unsurveyed. This applies even

[13] Reed, Ralph D.—Geology of California, Am. Assoc. Petroleum Geologists, 1933.

[14] Wilmarth, M. Grace, U. S. Geol. Survey, Bull. 826, 1931, accompanied by four advanced correlation charts: Chart I—Tentative correlation of geologic formations in Pacific border of California south of San Francisco region; Chart II—Tentative correlation of geologic formations in California north of San Francisco region and in Sierra Nevada; Chart III—Geologic formation names that have been used in California from San Francisco region southward. Chart IV—Geologic formation names that have been used in California north of the San Francisco region and in the Sierra Nevada.

to the Coast Ranges south of San Francisco, where concentrated efforts on the parts of oil geologists have produced such a wealth of geological knowledge. These small blank patches consist largely of pre-Tertiary formations.

The largest unmapped area lies in northwestern California. It comprises parts of two provinces, *i.e.*, (1) the Northern Coast Ranges, composed of a Mesozoic complex of sedimentary and other rocks, with superficial patches of Cenozoic beds; (2) the Klamath Mountains composed of a still more complex structure of both Mesozoic and pre-Mesozoic rocks of nearly every description. They are in some respects not unlike those of the Sierra Nevada.

Large expanses of Cenozoic lava beds have yet to be differentiated and mapped in northeastern California. Exposures of bedrock and superficial lake beds are also to be investigated.

The southern Sierra Nevada has large areas yet unexplored so far as mapping bedrock geology is concerned. Metamorphic rocks (included within large areas of granites), superficial patches of volcanics, and later glacial gravels have yet to be surveyed in detail.

The desert areas east and southeast of the Sierra Nevada are gradually being mapped in detail, though at present there are large and complex regions that intervene between the more explored mountain ranges. In southeastern California, particularly, there are conspicuous ranges whose geology still remains practically unknown. They all contain intricate problems in geologic structure.

The mapping of the southern coastal part of the state is gradually being completed; but there still remain unknown sections awaiting further study and accurate plotting.

Re-study of older problems in the light of new information always brings forth more advanced interpretations, which in turn present points of vantage that enable geologists to revise in better form areas already mapped.

On the whole, the stride we have made is far in advance of those of others who have preceded us, but we are still far from the goal of perfection.

We solicit, therefore, further interest and cooperation in the study. Contributions to any portion of the state map, and especially to the blank areas indicated on the accompanying index map, will be greatly appreciated.

ADJOINING STATE MAPS

Base maps of Nevada and Oregon, on the scale of 1:500,000, have been published by the U. S. Geological Survey, but so far the geology on them has only been partly compiled and not yet published.

Arizona[15] has not only a base and topographic map, scale 1 :500,000, but the geology has also been compiled and published.

A general geologic map of Lower California[16] is available on a scale of about 30 miles to one inch. It shows 13 geologic units.

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[15] Darton, N. H., Lausen, Carl, and Wilson, E. D.—Geologic map of the State of Arizona, scale 1:500,000: Arizona Bureau of Mines and U. S. Geol. Survey, 1924. (32 geologic units shown in colors and patterns.)

[16] Flores, Teodore—Carta geologica de la Baja California: Institute Geologico de Mexico, no. 1, 1931, 22 pp. (Carta geologica de la Baja California, escala 1:2,000,000.)

GEOLOGIC MAPS AND ACCOMPANYING REPORTS CONSULTED

(NOTE.—The symbol before the reference corresponds to the map symbol.)

Allen, Victor T.

The Ione formation of California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 18, 1929, pp. 347–448, figs. 2, 3, 4, 5. (*Fig. 2*—Geologic map of part of the Jackson quadrangle, California, modified after H. W. Turner, scale $\frac{5}{8}''=2$ mi. *Fig. 3*—Geological map and cross-section near Knight's Ferry, Copperopolis quadrangle, California, scale $1''=\frac{1}{4}$ mi. *Fig. 4*—Geological map and cross section near Merced Falls, modified after Sonora folio, California, scale $\frac{3}{4}''=1$ mi. *Fig. 5*—Geological map of part of the Chico quadrangle, California, modified after Lindgren, scale $\frac{1}{2}''=1$ mi.)

Anderson, Charles A.

The geology of the Engels and Superior mines, Plumas County, California: with a note on the ore deposits of the Superior mine: Univ. Cal. Bull. Dept. Geol. Sci., vol. 20, 1931-32, pp. 293-330, pl. 51. (Geologic map of a small area surrounding the Engels and Superior mines, scale $1\frac{1}{8}''=5000'$.)

Volcanic history of Glass Mountain, northern California: Am. Jour. Sci., vol. 26, 1933, pp. 485-506, fig. 3. (Geologic map of Glass Mountain and immediate environs. Scale $1''=1$ mi.)

A33 The Tuscan formation of northern California with a discussion concerning the origin of volcanic breccias: Univ. Cal. Bull. Dept. Geol. Sci., vol. 23, 1933, pp. 215-276, figs. 1, 7, 11, 12. (*Fig. 1*—Geologic map of a portion of northern California, scale $1''=15$ mi.; *Fig. 7*—Geologic map of a part of the Chico quadrangle, California, by Allen, scale $1''=2$ mi.; *Fig. 11*—Geologic map of Table Mountain, northeast of Red Bluff, modified from Marliave, scale $1''=2000'$; *Fig. 12*—Geologic map of Iron Canyon, northeast of Red Bluff, from Hamlin, scale $1\frac{3}{8}''=1$ mi.)

A36 Volcanic history of the Clear Lake area, California: Bull. Geol. Soc. Am., vol. 47, 1936, pp. 629-664, pl. 2. (Geologic map of the area surrounding the southern half of Clear Lake. Scale $9/16''=1$ mi.)

(and **Finch, R. H.**) The quartz basalt eruptions of Cinder Cone, Lassen Volcanic National Park, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 19, 1930, pp. 243-273, fig. 1. (Geologic map of Cinder Cone and vicinity, by C. A. Anderson, R. H. Finch, H. Williams, A. E. Jones. Scale $1\,3/16''=1$ mi.)

Anderson, Frank M.

The geology of Point Reyes Peninsula: Univ. Cal. Bull. Dept. Geol. Sci., vol. 2, 1899, pp. 119-153, pl. 4. (Geological map of Point Reyes Peninsula. Scale $1''=2$ mi.)

A stratigraphic study in the Mount Diablo Range of California: Proc. Cal. Acad. Sci., ser. 3, vol. 2, 1905, pp. 155-248, pl. XXXV. (Geological map of the Coalinga oil district. Scale $1''=1$ mi.)

The Neocene deposits of Kern River, California, and the Temblor Basin: Proc. Cal. Acad. Sci., ser. 4, vol. 3, 1911, pp. 73-148, pl. III. (Map of the southern part of the San Joaquin Valley. Scale $7/16''=5$ mi.)

Jurassic and Cretaceous divisions in the Knoxville-Shasta succession of California: State Mineralogist's Rept. 27, 1932, pp. 311-328, fig. 2. (Geological sketch map of the Paskenta-Lowry district. Scale $\frac{1}{2}''=6$ mi.)

Af33 Type-area of Jurassic Knoxvillian series of California: Pan-Am. Geologist, vol. 60, 1933, pp. 175-188, pl. XI. (North part of type area of Jurassic Knoxvillian series. South part of type area of Jurassic Knoxvillian series. Scale $\frac{1}{2}''=6$ mi.)

Knoxville-Shasta succession in California: Bull. Geol. Soc. Am., vol. 44, 1933, pp. 1237-1270, fig. 1. (Sketch map of Paskenta-Elder Creek district. Scale $\frac{3}{8}''=1$ mi.)

(and **Hanna, G. Dallas**) Fauna and stratigraphic relations of the Tejon Eocene at the type locality in Kern County, California: Occ. Papers, Cal. Acad. Sci., vol. 11, 1925, 249 pp., pl. 16. (Sketch map of areal geology of Tejon region based on Tejon and Mt. Pinos quadrangles, U. S. Geological Survey topographic map; area west of Salt Creek adapted from Clark.)

(and **Martin, Bruce**) Neocene record in the Temblor basin, California, and Neocene deposits of the San Juan district, San Luis Obispo County: Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, pp. 15-112, pls. 9, 10. (*Pl. 9*—Areal geology of the Temblor Basin outlined by F. M. Anderson. *Pl. 10*—Geologic map of the San Juan district northeastern San Luis Obispo County, California, scale ½″ = 1 mi.)

Anderson, George H.

Ag Generalized geologic map White Mountain quadrangle, scale 1 :62,500: California Institute of Technology, 1934. Unpublished.

Anderson, Robert

Preliminary report on the geology and possible oil resources of the south end of San Joaquin Valley, Cal.: U. S. Geol. Survey Bull. 471, 1910, pp. 106-136, pl. X. (Reconnaissance map of the southern end of the San Joaquin Valley, California. Scale 1:500,000.)

AP15 (and **Pack, R. W.**) Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 1915, 220 pp., pls. I, XIV. (*Pl. I*—Geologic map of the western border of San Joaquin Valley, Cal., between the Coalinga oil field and Livermore Pass, with geologic sections, by Robert Anderson and R. W. Pack, assisted by E. L. Ickes, scale 1:125,000. *Pl. XIV*—Geologic map of part of the Tesla quadrangle, scale 1:125,000.)

Andrews, Philip

Ap36 Geology of the Pinnacles National Monument: Univ. Cal. Bull. Dept. Geol. Sci., vol. 24, 1936, 38 pp., map 1. (The Pinnacles National Monument: Areal geology and sections. Scale 1″ = ½ mi.)

Arnold, Ralph

The paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California: Memoirs, Cal. Acad. Sci., vol. 3, 1903, 420 pp., pl. XXII. (Section Deadman Island. Scale 1″ = 600 yds.)

Ar07 Geology and oil resources of the Summerland district, Santa Barbara County, California: U. S. Geol. Survey Bull. 321, 1907, 93 pp., pl. 1. (Geological and structural map of the Summerland oil district. Scale 1:62,500.)

Topography and fault system of the region of the San Jacinto earthquake: Bull. Seis. Soc. Am., vol. 8, 1918, pp. 68-72, pl. 13. (Map of San Jacinto fault zone, San Bernardino, Riverside, San Diego and Imperial Counties, California. Scale ⅜″=5 mi.)

AA07 (and **Anderson, R.**) Geology and oil resources of the Santa Maria oil district, Santa Barbara County, California: U. S. Geol. Survey Bull. 322, 1907, 161 pp., pl. I. (Preliminary geologic and structural map of the Santa Maria district. [Lompoc and Guadalupe quadrangles.] by R. Arnold, R. Anderson, H. R. Johnson, and H. W. Fairbanks. Scale 1:125,000.)

AA08 (and **Anderson, R.**) Preliminary report on the Coalinga oil district, Fresno and Kings Counties, California: U. S. Geol. Survey Bull. 357, 1908, 142 pp., pl. I. (Geologic and structural map of the Coalinga district. Scale 1:125,000.)

AJ10 (and **Johnson, H. R.**) Preliminary report on the McKittrick-Sunset oil region, Kern and San Luis Obispo Counties, California: U. S. Geol. Survey Bull. 406, 1910, 225 pp., pl. I. (Preliminary geological and structural map of the McKittrick-Sunset oil region, California. Scale 1:125,000.)

Averill, Charles Volney

Ac31 Preliminary report on economic geology of the Shasta quadrangle: State Mineralogist's Rept. 27, 1931, pp. 3-65. (Geology-Shasta quadrangle, areal geology by Geological Dept. of Southern Pacific Company. Scale 1″ = 4 mi.)

Ac Geologic map of the Big Bar quadrangle, California, scale 1:125,000: Cal. State Div. Mines, 1934. Unpublished.

Bailey, Thomas L.

The geology of the Potrero Hills and Vacaville region, Solano County, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 19, 1930, pp. 321-333, pls. 39, 40. (*Pl. 39*—Geology of the Potrero Hills and Vacaville region Solano Co., California, scale $\frac{5}{8}$"=2 mi. *Pl. 40*—Section across center of Potrero Hills, scale 1"=2,000'.)

Baker, Charles Laurence

Notes on the later Cenozoic history of the Mohave Desert region in southeastern California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 6, 1911, pp. 333-383, pl. 34 (Map, scale 1:750,000.)

Ball, Sydney H.

B07 A geologic reconnaissance in southwestern Nevada and eastern California: U. S. Geol. Survey Bull. 308, 1907, 218 pp., pl. I. (Geologic reconnaissance map of portions of southwestern Nevada and eastern California. [North half of Ballarat quadrange.] Scale 1:250,000.)

Barbat, W. F., and Galloway, John

San Joaquin clay, California: Bull. Am. Assoc. Pet. Geol., vol. 18, 1934, pp. 476-499, figs. 1, 2. (Map and geologic sections. Scale $\frac{3}{4}$" = 24 mi.)

Beal, Carl H.

Bh Geologic map of the Monterey quadrangle, scale 1:62,500: Stanford University, 1915. Unpublished M.A. thesis.

Becker, George F.

Geology of the quicksilver deposits of the Pacific slope with an atlas: U. S. Geol. Survey Mono. 13, 1888, 486 pp., atlas sheets 3, 4, 5, 6, 7, pls. 5, 6, 7, fig. 18. (*Sh. 3*—Geological map of the Clear Lake district, scale 1" = $1\frac{1}{2}$" mi. *Sh. 4*—Geological map of the Sulphur Bank district, scale 1" = 1250'. *Sh. 5*—Geological map of the Knoxville district, scale 1" = 1250'. *Sh. 6*—Geological map of the New Idria district, scale 1" = 1250'. *Sh. 7*—Geological map of the New Almaden mining district, scale 1" = 1250'. *Pl. 5*—Oat Hill mine, Napa County, California, scale 1" = 1250'. *Pl. 6*—Great Western quicksilver mine, Lake County, California, scale 1" = 1250'. *Pl. 7*—Great Eastern quicksilver mine, Sonoma County, California, scale 1" = 1250'. *Fig. 18*—Geological sketch map of the Mayacmas Range, scale 1" = 3 mi.)

Blackwelder, Eliot

Glacial and associated stream deposits of the Sierra Nevada. State Mineralogist's Rept. 28, 1932, pp. 302-310, pl. II. (Map of the Sierra Nevada, California, showing distribution of glaciers in late Pleistocene time. (Scale 1" = 12 mi.)

Lake Manly: an extinct lake of Death Valley: Geog. Rev., vol. 23, 1933, pp. 464-471, fig. 1. (Map of Death Valley and vicinity, showing the probable extent of lakes and rivers during the Tahoe glacial age of the Pleistocene period. Scale 13/16" = 24 mi.)

Be Geologic maps of the Bridgeport quadrangle, the northeast part of Mt. Goddard quadrangle, and the north part of the Dardanelles quadrangle, scale 1:125,000: Stanford University, 1934. Unpublished.

Blake, William Phipps

Early contributions to the geology of California.

Boyle, A. C., Jr.

The geology and ore deposits of the Bully Hill mining district, California: Am. Inst. Min. Eng. Trans., vol. 48, 1914, pp. 67-115, fig. 1. (Map of Bully Hill mining district, with generalized section. Scale $\frac{3}{8}$" = 1000'.)

Branner, J. C., Newsome, J. F., and Arnold, Ralph

BNA09 Santa Cruz folio, California (no. 163): U. S. Geol. Survey Geol. Atlas, 1909, 11 pp. (Areal geology sheet. Scale 1:125,000.)

Bremner, Carl St. J.

Geology of Santa Cruz Island, Santa Barbara County, California: Occ. Papers no. 1, Santa Barbara Mus. Nat. Hist., 1932, 33 pp., pls. 4, 5. (*Pl. 4*—Geologic map Santa Cruz Island Santa Barbara County, scale 1″ = 1 mi., by C. St. J. Bremner and J. M. Kirby. *Pl. 5*—Geologic map southwestern part of Santa Cruz Island, Santa Barbara County, California, scale 1″ = 2000′, by C. St. J. Bremner and J. M. Kirby.)

Bc33 Geology of San Miguel Island Santa Barbara County, California: Occ. Papers no. 2, Santa Barbara Mus. Nat. Hist., 1933, 23 pp., pl. 4. (Geologic map San Miguel Island Santa Barbara County, California. Scale 2″ = 1 mi.)

Brown, Arthur B., and Kew, W. S. W.

Occurrence of oil in metamorphic rocks of San Gabriel Mountains, Los Angeles County, California: Bull. Am. Assoc. Pet. Geol., vol. 16, 1932, pp. 777-785, figs. 1, 2. (*Fig. 1*—Generalized map showing location of Placerita Canyon wells with respect to basement complex and sedimentary rocks, scale ¼″ = 1 mi. *Fig. 2*—Geologic map of Placerita Canyon in vicinity of wells, scale 1:24,000.)

Brown, John S.

The Salton Sea region, California: U. S. Geol. Survey Water-Supply Paper 497, 1923, 292 pp., pl. XII. (Reconnaissance geologic map of Salton Sea region, California. Scale 1:500,000.)

Bryan, Kirk

Geology and ground-water resources of Sacramento Valley, California: U. S. Geol. Survey Water-Supply Paper 495, 1923, 285 pp., pl. III. (Map of Sacramento Valley, showing geology, physiography, and location of flood basins. Scale ½″ = 10 mi.)

Burger, R. W.,

Unpublished data on geology of the Coast Ranges.

(and **Hobson, H. D.**) Geology of a portion of San Joaquin Hills, Orange County, Calif. Scale ¾″ = 1 mi.: *in* Structural evolution of Southern California by R. D. Reed and J. S. Hollister, Am. Assoc. Pet. Geol., vol. 20, 1936, 1721 pp., fig. 45.)

Buwalda, John P.

Pleistocene beds at Manix in the eastern Mojave Desert region: Univ. Cal. Bull. Dept. Geol. Sci., vol. 7, 1914, pp. 443-464, pl. 22. (Sketch map showing approximate limits of Manix beds. Scale 1″ = 6 mi.)

Bj Geologic map of Tejon and Mojave quadrangles, scale 1:125,000: California Institute of Technology, 1934. Unpublished.

Calkins, Frank C.

The granitic rocks of the Yosemite region, *in* Geologic history of the Yosemite Valley by François E. Matthes: U. S. Geol. Survey Prof. Paper 160, 1930, appendix, pp. 120-129. (Generalized geologic map of part of the Yosemite region, California. Scale 1:125,000.)

Cartwright, Lou D., Jr.

Sedimentation of the Pico formation in the Ventura quadrangle, California: Bull. Am. Assoc. Pet. Geol., vol. 12, 1928, pp. 235-269, figs. 2, 5. (*Fig. 2*—Areal distribution of formations in a part of the Ventura district, scale 1″ = 6 mi. *Fig. 5*—Map of Pliocene of the Ventura quadrangle, by Stanford Geological Survey 1926 with additional details by L. D. Cartwright, Jr., scale 7/16″ = 1 mi.)

Clark, Bruce L.

The Neocene section at Kirker Pass on the north side of Mount Diablo: Univ. Cal. Bull. Dept. Geol. Sci., vol. 7, 1912, pp. 47-60, pl. 7. (Outline map of formations at Kirker Pass.)

The stratigraphic and faunal relationships of the Meganos group, Middle Eocene of California: Jour. Geol., vol. 29, 1921, pp. 125-165, figs, 2, 7. (*Fig. 2*—

Areal map of the Eocene deposits to the north of Mount Diablo. *Fig. 7*—Areal map, showing distribution of Eocene and Oligocene outcrops at the south end of the San Joaquin Valley, scale 5/16″ = 1 mi.)

Tectonics of the Valle Grande of California: Bull. Am. Assoc. Pet. Geol., vol. 13, 1929, pp. 199-238, figs. 3, 4. (*Fig 3*—Geologic maps of the southwest border area of Valle Grande in the vicinity of McKittrick, California, scale ½″ = 5 mi. *Fig. 4*—Geologic map of the western border of Valle Grande in the vicinity of Coalinga, California, scale ½″ = 5 mi.)

Tectonics of the Coast Ranges of middle California: Bull. Geol. Soc. Am., vol. 41, 1930, pp. 747-828, pls. 16, 22, figs, 1, 2, 3. (*Pl. 16*—Map showing positions of principal known primary faults in the Coast Ranges, scale 1⅛″ = 100 mi. Paleogeographic maps of southeastern portion of San Francisco Bay area showing: *Fig. 1*—extent of Martinez sea; *Fig. 2*—extent of Meganos-Domengine Tejon sea; *Fig. 3*—extent of Siesta-Orinda continental deposits; scale 1:125,000. *Pl. 22*—Diagrammatic map of a portion of California showing positions of principal positive and negative areas in middle California during the Cretaceous and Tertiary periods.

Geologic map of the Byron quadrangle, Mt. Diablo region, scale 1:62,500: University of California, 1932. Unpublished.

Tectonics of the Mount Diablo and Coalinga areas, middle Coast Ranges of California: Bull. Seis. Soc. Am., vol. 46, 1935, pp. 1025-1078, pls. 48, 89, 90, figs. 8, 9. (*Pl. 48*—Geologic map along the Riggs Canyon fault, scale 1″ = 2 mi. *Pl. 89*—Geologic map and cross sections of the western border of Valle Grande in the vicinity of Coalinga, California, scale 1:125,000. *Pl. 90*—Map showing positions of known primary faults and major blocks in the middle Coast Ranges of California, scale 1″ = 60 mi. *Fig. 8*—Map of structures along the Kreyenhagen Hills fault. *Fig. 9*—Coast Range area west of Coalinga in Cretaceous, Eocene, Middle Miocene, and Upper Miocene periods.)

Clements, Thomas

C Geologic map of the southeast corner of the Tejon quadrangle, scale 1:125,000: California Institute of Technology, 1931. Unpublished.

Cloos, Ernst

Ce33 Structure of the Sierra Nevada batholith: Int. Geol. Cong., Guidebook 16, 1933, pp. 40-45, pl. 7. (Map and structure section of a portion of the Sierra Nevada batholith: Scale ⅞″ = 5 mi. Reprint after Geol. Rundschau, Band 22, pl. 2.)

Cogen, William M.

Heavy mineral zones in the Modelo formation of the Santa Monica Mountains, California: Jour. Sed. Petrology, vol. 6, 1936, pp. 3-15, figs. 1, 2. (*Fig. 1*—Geologic map of a part of the Santa Monica Mountains, scale ½″ = 1 mi. Adapted from geologic map in U. S. G. S. Prof. Paper 165 by H. W. Hoots. *Fig. 2*—Map of the heavy mineral zones of the Modelo formation, scale 1″ = 1 mi.)

Corby, Grant White

The geology and paleontology of the San Joaquin and Niguel Hills, Orange County, California: Stanford University, 1922. (Geology and paleontology of the San Joaquin and Niguel Hills, Orange County, California. Scale 1″ = 1 mi.) Unpublished M. A. thesis.

Crandall, Roderic

The geology of the San Francisco Peninsula: Am. Phil. Soc. Proc., vol. 46, 1907, pp. 3-58. (Geological map of the San Francisco Peninsula. Scale ½″ = 2 mi.)

Cunningham, George M.

The Wheeler Ridge oil field: Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, pp. 495-501, fig. 1. (Geologic map of Wheeler Ridge anticline. Scale ¾″ = 1 mi.)

Darton, N. H.

Guidebook of the western United States, Part F, the Southern Pacific lines New Orleans to Los Angeles: U. S. Geol. Survey Bull. 845, 1933, 304 pp., sheets 26,

27, 28, 29. (*Sh. 26*—California-Arizona, geology by J. S. Brown. *Sh. 27*—California, geology by J. S. Brown, San Andreas and Mission Creek faults by L. F. Noble. *Sh. 28*—California, geology by F. E. Vaughan, G. A. Waring, D. M. Frazer, W. J. Miller, and others. *Sh. 29*—California, geology by W. A. English, W. S. W. Kew, H. W. Hoots, and others; San Andreas fault-Cajon Pass region by L. F. Noble. Scale 1:500,000.)

(and others) Guidebook of the western United States, Part C, the Santa Fe Route with a side trip to the Grand Canyon of the Colorado: U. S. Geol. Survey Bull. 613, 1915, 194 pp., sheets 21, 22, 23, 24. (Geologic and topographic map of the Santa Fe Route from Kansas City, Missouri, to Los Angeles, California. Scale 1:500,000.)

Davidson, George

The submerged valleys of the coast of California, U. S. A., and of Lower California, Mexico: Proc. Cal. Acad. Sci., ser. 3, vol. 1, 1897, pp. 73-103, pls. IV-XII.

Decius, L. C.

Unpublished data on geology of the Coast Ranges, including southern Orange County.

Dibblee, T. W., Jr.

Dt Geologic map of the Lompoc, Goleta, and Santa Barbara quadrangles, scale 1:62,500: Stanford University, 1935. Unpublished.

Dickerson, Roy Ernest

Dr14 Fauna of the Martinez Eocene of California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 8, 1914, pp. 61-180, figs. 3, 4. (*Fig. 3*—Map showing Martinez area north of Mount Diablo; scale $\frac{1}{2}'' = 1$ mi. *Fig. 4*—A sketch map showing the areal distribution of the Martinez and the formations in contact with it near Lower Lake, Lake County, California, scale $\frac{3}{4}'' = 1$ mi.)

The Martinez Eocene and associated formations at Rock Creek on the western border of the Mojave Desert area: Univ. Cal. Bull. Dept. Geol. Sci., vol. 8, 1914, pp. 289-298, fig. 1. (A geological map of a portion of the Rock Creek quadrangle, Los Angeles County, California. Scale $1'' = 1$ mi.)

Stratigraphy and fauna of the Tejon Eocene of California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 9, 1916, pp. 363-524, map, figs. 4, 5, 8. (Map showing Tejon and associated groups in area south of Mount Diablo, by 1911 and 1912 Summer School classes in paleontology, scale $\frac{3}{4}'' = 1$ mi. *Fig. 4*—Geological map of Oroville and Table Mountain, a portion of the Chico quadrangle, adapted from Lindgren, scale $\frac{1}{2}'' = 1$ mi. *Fig. 5*—Geological map of a portion of the Jackson quadrangle, adapted from the Jackson folio, scale $\frac{1}{2}'' = 1$ mi. *Fig. 8*—Map showing type locality of Tejon group, after R. Anderson, scale 1:500,000.)

Tertiary and Quaternary history of the Petaluma, Point Reyes and Santa Rosa quadrangles: Proc. Cal. Acad. Sci., ser. 4, vol. 11, 1922, pp. 527-601, pls. 17, 18. (*Pl. 17*—Geological map showing the distribution of the Tertiary formations in the Santa Rosa and Petaluma quadrangles, scale $1'' = 3$ mi. *Pl. 18*—Reconnaissance geological map of the Point Reyes triangle after F. M. Anderson, with additions by R. E. Dickerson, scale $\frac{3}{4}'' = 2$ mi.)

Diller, Joseph S.

Geology of the Lassen Peak district: U. S. Geol. Survey Ann. Rept. 8, 1886, pp. 395-432, pl. XLVII. (Geologic map of Lassen Peak district. Scale 1:400,000.)

Geology of the Taylorville region of California: Bull. Geol. Soc. Am., vol. 3, 1892, pp. 369-394.

D95 Lassen Peak folio, California (no. 15): U. S. Geol. Survey Geol. Atlas, 1895 (prel. ed. 1892), 3 pp. (Areal geology sheet. Scale 1:250,000.)

D06 Redding folio, California (no. 138): U. S. Geol. Survey Geol. Atlas 1906, 14 pp. (Areal geology sheet. Scale 1:250,000.)

D08 Geology of the Taylorsville region, California: U. S. Geol. Survey Bull. 353, 1908, 128 pp., pls. II, III. (*Pl. II*—Topography and geology of the

southern half of Honey Lake quadrangle, California, scale 1:250,000. *Pl. III*—Topography and geology of area covered by Indian Valley map, scale 1:65,500, by J. S. Diller and James Storrs.)

Auriferous gravels of the Weaverville quadrangle, California: U. S. Geol. Survey Bull. 540, 1912, pp. 11-21, fig. 1, pl. 1. (*Fig. 1*—Geologic map of the Klamath Mountains and adjacent ranges, California, scale 9/16″ = 40 mi. *Pl. 1*—Map showing auriferous gravels of the middle and northern portions of the Weaverville quadrangle, California, scale 1″ = 5 mi.)

Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, 1914, 147 pp., pl. VI. (Geologic reconnaissance map of the Galice-Kerby-Waldo region. Scale 1⅜″ = 6 mi.)

D15 Guidebook of the western United States, Part D, the Shasta route and coast line: U. S. Geol. Survey Bull. 614, 1915, 142 pp., sheets 1A-6A, 7, 13. (*Shs. 1A-6A*—Geologic and topographic map of the coast route from Los Angeles, California, to San Francisco, California. *Sh. 7*—Geologic and topographic map of the Shasta Route from Seattle, Washington, to San Francisco, California. *Sh. 13*—Geologic and topographic map of the Shasta and coast routes from Seattle, Washington, to San Francisco, California, and from Los Angeles, California, to San Francisco, California. Scale 1:500,000.)

Guidebook of the western United States, Part D, the Shasta route and coast line: U. S. Geol. Survey Bull. 614, 1915, 142 pp., sheet 8. (Geologic and topographic map of the Shasta route from Seattle, Washington, to San Francisco, California. Scale 1 :500,000.)

D15′ Mount Shasta, some of its geologic aspects: Mazama, vol. 4, no. 4, 1915, pp. 11-16, fig. 6. (Geologic map of Mount Shasta, California, scale 1″=3 mi.)

D Geologic map of the Big Bar quadrangle, California, scale 1:96,000: U. S. Geol. Survey, 1934. Unpublished.

(and **Stanton, T. W.**)—The Shasta-Chico series: Bull. Geol. Soc. Am., vol. 5, 1894, pp. 435-464, fig. 1. (Map showing approximately the coastlines at close of Horsetown and Chico epochs.)

Donnelly, Maurice

Dm34 Geology and mineral deposits of the Julian district, San Diego County, California: State Mineralogist's Rept. 30, 1934, pp. 331-370, pl. IV. (Geologic map of Julian district, San Diego County, California. Scale ¾″ = 4000′.)

Dudley, Paul H.

Dp35 Geology of a portion of the Perris block, southern California: State Mineralogist's Rept. 31, 1935, pp. 487-506. (Geologic map of portion of Perris block, southern California. Scale ⅜″ = 1 mi.)

Durrell, Cordell

Dc Geologic map of the Kaweah River district, including parts of Kaweah, Tehipite, Dinuba, Lemon Cove, Rocky Hill, Exeter, and Ivanhoe quadrangles, scale 1:125,000: University of California, 1934. Unpublished.

Eaton, J. E.

A contribution to the geology of Los Angeles basin, California: Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, pp. 753-767, fig. 1. (Geology and oil developments of Los Angeles basin. Scale ⅜″ = 4 mi.)

Ej Geologic map of the Caliente Range, scale 1″ = 2 mi.: 1935. Unpublished.

Eckis, Rollin

Er Geologic maps of part of the Ramona quadrangle, scale 1:125,000; parts of the Oceanside and Escondido quadrangles, scale 1 :62,500; south part of the Indio quadrangle, scale 1:62,500: Pomona College, 1931. Unpublished.

Er34 Geology and groundwater storage capacity of valley fill: Cal. State Div. Water Resources Bull. 45, 1934, 273 pp., pls. A, B, C. (*Pl. A*—Geologic map of San Fernando and San Gabriel valleys and adjacent areas. *Pl. B*—Geologic

map of coastal plain and adjacent areas. *Pl. C*—Geologic map of upper Santa Ana Valley and adjacent areas. Scale $\frac{7}{8}'' = 2$ mi.)

Also unpublished data.

Eldridge, George Homans, and Arnold, Ralph

The Santa Clara Valley, Puente Hills and Los Angeles oil districts, southern California: U. S. Geol. Survey Bull. 309, 1907, 266 pp., pls. I, XVIII. (*Pl. I*—Geologic map of the Santa Clara Valley and adjacent oil fields, Ventura and Los Angeles Counties, California, by George H. Eldridge, scale 1:62,500. *Pl. XVIII*—Geologic map of the region of Los Angeles oil fields, California, by Ralph Arnold, scale 1:62,500.)

Ellis, Arthur J., and Lee, Charles H.

EL19 Geology and ground waters of the western part of San Diego County, California: U. S. Geol. Survey Water-Supply Paper 446, 1919, 321 pp., pl. III. (Preliminary geologic map of San Diego County, California. Scale 1:250,000.)

English, Walter A.

E16 Geology and oil prospects of Cuyama Valley, California: U. S. Geol. Survey Bull. 621, 1916, pp. 191-215, pl. XIX. (Geologic map of Cuyama Valley, California, by W. A. English and W. Gordon. Scale 1:125,000.)

E18 Geology and oil prospects of the Salinas Valley-Parkfield area, California: U. S. Geol. Survey Bull. 691, 1918, pp. 219-250, pl. XXVIII. (Geologic map of Parkfield district, California, by W. A. English and W. S. W. Kew. Scale 1:62,500.)

E21 Geology and petroleum resources of northwestern Kern County: U. S. Geol. Survey Bull. 721, 1921, 48 pp., pl. I. (Geologic map and sections of northwestern Kern County, California, by W. A. English and W. S. W. Kew. Scale 1:125,000.)

Geology and oil resources of the Puente Hills region, southern California, with a section on the chemical character of the oil by Paul W. Prutzman: U. S. Geol. Survey Bull. 768, 1926, 110 pp., pl. I. (Geologic map and sections of the Puente Hills region, southern California, by W. A. English and W. S. W. Kew. Scale 1:62,500.)

Erwin, Homer D.

Eh34 Geology and mineral resources of northeastern Madera County, California: State Mineralogist's Rept. 30, 1934, pp. 7-78, pl. I. (Geological map of northeastern Madera County, California. Scale $1'' = 1\frac{1}{2}$ mi.)

Ewing, Sydney C.

Geologic map of the Mt. Ingalls district, Plumas County, California: scale $\frac{3}{4}'' = 1$ mi. Stanford University, 1927. Unpublished M. A. thesis.

Fairbanks, Harold Wellman

Geology of the Mother Lode region: Cal. State Min. Bur. Rept. 10, 1890, pp. 23-90. (Geological map of the Mother Lode region. Scale $1'' = 1$ mi.)

Geology and mineralogy of Shasta County: State Mineralogist's Rept. 11, 1891-92, pp. 24-53. (Geological map of Shasta County by Wm. Irelan, Jr., and H. W. Fairbanks. Scale $1\frac{3}{8}'' = 6$ mi.)

Geology of San Diego; also of portions of Orange and San Bernardino Counties: Cal. State Min. Bur. Rept. 11, 1893, pp. 76-120. (Geological map of portions of San Diego, Orange and San Bernardino Counties. Scale $1'' = 6$ mi.)

The geology of Point Sal: Univ. Cal. Bull. Dept. Geol. Sci., vol. 2, 1896, 92 pp., pl. I. (Geological map of Point Sal. Scale 1:63,360.)

F04 San Luis folio, California (no. 101): U. S. Geol. Survey Geol. Atlas, 1904, 14 pp. (Areal geology sheet. Scale 1:125,000.)

Ferguson, Henry G.

Gold lodes of the Weaverville quadrangle, California: U. S. Geol. Survey Bull. 540, 1912, pp. 22-79, pl. II. (Geologic map of part of the Weaverville quadrangle, California. Scale $\frac{1}{4}'' = 1$ mi.)

Fh Geologic map of the Hawthorne quadrangle, scale 1:250,000: U. S. Geol. Survey, 1934. Unpublished.

(and **Gannett, R. W.**) Gold quartz veins of the Alleghany district, California; U. S. Geol. Survey Prof. Paper 172, 1932, 139 pp., pl. 3. (Geologic map of the vicinity of Alleghany, California. [Parts of the Colfax, Downieville, Bidwell Bar, and Smartsville folios.] Scale 1:125,000.)

Fitch, A. A.

The geology of Ben Lomond Mountain: Univ. Cal. Bull. Dept. Geol. Sci., vol. 21, 1931, 13 pp. (Geologic map of San Vicente Creek. Scale 2″=600′.)

Forstner, William

Fw03 The quicksilver resources of California: Cal. State Min. Bur. Bull. 27, 1903, 273 pp. (Geological map of portions of Napa, Sonoma and Lake County quicksilver districts, scale 1″=1 mi. Geological map of Napa, Sonoma, Lake, and Yolo quicksilver districts, scale 1″=2 mi. Geological map of quicksilver district in southern portion of San Benito County, scale 1″=1 mi. Geological map of quicksilver districts northwestern portion of San Luis Obispo County, scale 1″=1 mi. Map of the New Almaden mining district, scale 1″=2 mi.)

Fox, Leo S.

Structural features of the east side of the San Joaquin Valley, California: Bull. Am. Assoc. Pet. Geol., vol. 13, 1929, pp. 101-108, fig. 1. (Geologic map of a portion of east side San Joaquin Valley, Kern County, California. Scale ¾″=4 mi.) Also unpublished data.

Fraser, Donald McCoy

Fd31 Geology of San Jacinto quadrangle south of Gorgonio Pass, California: State Mineralogist's Rept. 27, 1931, pp. 494-540. (Geologic map of the San Jacinto quadrangle south of San Gorgonio Pass. Scale 1:125,000.)

Frederick, F.

Ff Geologic map of the Bodie district, Bridgeport quadrangle, scale 1:500,000: University of California, 1935. Unpublished.

Galbraith, M. M.

Gm Geologic map of the Inyo Mountains, scale 1:125,000: City of Los Angeles, Department of Water and Power, 1936. Unpublished.

Gale, Hoyt S.

Geology of Huntington Beach oil field, California: Bull. Am. Assoc. Pet. Geol., vol. 18, 1935, pp. 327-342, figs. 1, 3. (*Fig. 1*—Geologic map of Los Angeles basin reproduced from *Guidebook to Southern California, 16th Internal. Geol. Congress* (1933), by H. W. Hoots, W. S. W. Kew; added details by H. S. Gale, scale 1⅛″=10 mi. *Fig. 3*—Huntington Beach oil field, scale ⅛″=½ mi.)

Galliher, Edgar Wayne

Miscellaneous contributions in the southern Coast Ranges; compilation of geology of the Coast Ranges.

Gardner, Dion L.

G Geologic map of the Newberry, Ord and northern part of Bristol Mountains, southern California, scale 1″=2 mi: University of California. Unpublished M. A. thesis.

Gazin, C. Lewis

Gc Geologic map of part of the Mt. Pinos quadrangle, scale 1:125,000: California Institute of Technology, 1931. Unpublished.

Gester, G. C.

Geology of a portion of the McKittrick district, a typical example of the west side San Joaquin Valley oil fields, and a correlation of the oil sands of the west side fields: Proc. Cal. Acad. Sci., ser. 4, vol. 7, 1917, pp. 207-227, pl. 32. (Geologic map. Scale 1″=1 mi.)

(and **Galloway, John**) Geology of Kettleman Hills oil field, California: Bull. Am. Assoc. Pet. Geol., vol. 17, 1933, pp. 1161-1193, fig. 2. (Map showing principal formations in Kettleman Hills district, San Joaquin Valley, California. Scale $\frac{7}{8}'' = 6$ mi.)

Giffen, L. F.

Unpublished data on geology of the Coast Ranges.

Goudkoff, Paul P.

Subsurface stratigraphy of Kettleman Hills oil field, California: Bull. Am. Assoc. Pet. Geol., vol. 18, 1934, pp. 435-475, fig. 1. (Index map of a part of San Joaquin Valley including Kettleman Hills and adjacent areas. Scale $\frac{3}{4}'' = 18$ mi.)

Gregerson, A. I.

Unpublished data on geology of the Coast Ranges.

Hanna, G. D.

Unpublished data on geology of the northern Coast Ranges.

Hanna, Marcus A.

Hm26 Geology of the La Jolla quadrangle, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 16, 1926, pp. 187-246. (Geologic map of La Jolla quadrangle. Scale 1:62,500.)

Hazzard, John C.

Notes on the Cambrian rocks of the eastern Mojave Desert, California, with a paleontological report by Colin H. Crickmay: Univ. Cal. Bull. Dept. Geol. Sci., vol. 23, 1933, pp. 57-80, map 1. (Geological map of the Providence, Marble and Ship Mountains showing distribution of Lower and Middle Cambrian formations. Scale $1'' = 3$ mi.)

Hj Geologic map of the area between 34°-35° lat., and 115°-116° long. Unpublished.

Henny, Gerard

Some notes on the geology of the south San Joaquin Valley, California: Bull. Am. Assoc. Pet. Geol., vol. 11, 1927, pp. 611-615, fig. 1. (Fault system in the Cholame area. Scale $1\frac{3}{8}'' = 6$ mi.)

McLure shale of the Coalinga region, Fresno and Kings Counties, California: Bull. Am. Assoc. Pet. Geol., vol. 14, 1930, pp. 403-410, fig. 3. (Waltham Creek and Reef Ridge area, Fresno County, California. Scale $2\frac{3}{8}'' = 5$ mi.)

Herold, C. Lathrop

Hl Geologic map of the Salinas and Jamesburg quadrangles, scale 1 : 62,500: University of California, 1934. Unpublished.

Hershey, Oscar H.

Del Norte County Geology: Min. Sci. Press, vol. 102, 1911, p. 468. (Geological map, Del Norte County, California. Scale $\frac{7}{8}'' = 6$ mi.)

The geology of Iron Mountain: Min. Sci. Press, vol. 111, 1915, pp. 633-638. (Geologic map of the Iron Mountain region Shasta County, California. Scale $\frac{5}{8}'' = 300'$.)

Hertlein, L., and Grant, U. S. IV.

HG The geology and paleontology of the Pliocene of San Diego, California: Stanford University, 1929. (Sketch map of areal geology of the San Diego Pliocene, based on Southern California sheet no. 2, U. S. Geological Survey topographic map. Scale 1:62,500.) Unpublished.

Hewett, D. F.

Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, 1931, 172 pp., pl. I. (Geologic map of the Goodsprings quadrangle, Nev.-Cal. Scale 1:62,500.)

Hd Geologic map of the Ivanpah quadrangle, scale 1:250,000: U. S. Geol. Survey, 1934. Unpublished.

Hewett, D. F., Callaghan, Eugene, Moore, B. N., Nolan, T. B., Rubey, W. W., and Schaller, W. T.

Mineral resources of the region around Boulder Dam: U. S. Geol. Survey Bull. 871, 1936, 197 pp., pl. 1. (Geologic map of the Kramer borate area, California. Scale 1¼″ = 1 mi.)

Hill, Mason L.

Structure of the San Gabriel Mountains, north of Los Angeles, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 19, 1930, pp. 137-170, pl. 15. (Geology of a portion of the San Fernando quadrangle by H. J. Buddenhagen and Mason L. Hill. Scale 1¾″ = 2 mi.)

Mechanics of faulting near Santa Barbara, California: Jour. Geol., vol. 40, 1932, pp. 535-556, fig. 3. (Fault map of the Santa Ynez foothill belt. Scale 1:125,000.)

Hill, Robert T.

Southern California geology and Los Angeles earthquakes: Southern Cal. Acad. Sci., Los Angeles, 1928, 232 pp., pls. I, II. (Physiographic units of Southern California. Master fault rifts of Southern California. Scale 1″ = 36 mi.)

Hinds, Norman E. A.

Paleozoic eruptive rocks of the southern Klamath Mountains, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 20, 1932, pp. 375-410, fig. 2. (Geologic map of the southern Klamath Mountains, California. Modified from the geologic map of the State of California, State Mining Bureau, 1916. Scale ¾″ = 12 mi.)

Hn33 Geologic formations of the Redding-Weaverville districts, northern California: State Mineralogist's Rept. 29, 1933, pp. 77-122, pl. III. (Geologic map of the Redding and Weaverville quadrangles and the northwestern part of the Red Bluff quadrangle. Scale 1″ = 4 mi.)

Hoots, H. W.

Oil and gas exploration in southwestern Humboldt County, California: Press Release, Dept. of Interior, Mar. 5, 1928. (Geologic map and sections of southwestern Humboldt County, California.)

H30 Geology and oil resources along the southern border of San Joaquin Valley: U. S. Geol. Survey Bull. 812, 1930, pp. 243-332, pl. XXXI. (Geologic map and sections of the foothills along the southern and southeastern border of San Joaquin Valley, Kern County, California, by H. W. Hoots, R. W. Pack, A. T. Schwennesen, and J. D. Northrop. Scale 1:62,500.)

H31 Geology of the eastern part of the Santa Monica Mountains: U. S. Geol. Survey Prof. Paper 165, 1931, pp. 83-134, pl. XVI. (Geologic map of the eastern part of the Santa Monica Mountains and adjacent areas, Los Angeles County, California, by H. W. Hoots and W. S. W. Kew. Scale 1:24,000.)

H32 Oil development in the Los Angeles basin: Int. Geol. Cong., Guidebook 15, 1932, pp. 26-30, pl. 6. (Geologic map of Los Angeles basin, by H. W. Hoots and W. S. W. Kew. Scale ¼″ = 2 mi.)

Hudson, F. S.

Geology of the Cuyamaca region of California with special reference to the origin of the nickeliferous pyrrhotite: Univ. Cal. Bull. Dept. Geol. Sci., vol. 13, 1922, pp. 175-252. (Geological map of the Cuyamaca region. Scale 15/16″ = 1mi.)

Hulin, Carlton D.

Hc25 Geology and ore deposits of the Randsburg quadrangle of California: Cal. State Min. Bur. Bull. 95, 1925, 152 pp., pl. I. (Geology. Scale 1:62,500.)

Hc Geologic map of the Searles Lake quadrangle, scale 1″ = 4 mi.: University of California, 1935. Unpublished.

James, W. E.

Unpublished data on geology of the Coast Ranges.

Jenkins, Olaf P.

Report accompanying geologic map of northern Sierra Nevada: State Mineralogist's Rept. 28, 1932, pp. 279-298. (Geologic map of northern Sierra Nevada showing Tertiary river channels and Mother Lode belt. Scale 1″ = 8 mi.)

Johnson, F. A.

Jf Geologic map of a portion of Sonoma and Marin Counties, California, scale 1″ = 1 mi.: University of California, 1934. Unpublished.

Johnson, Harry R.

Geologic map of the Lompoc quadrangle, scale 1:125,000. Unpublished.

Jh Geologic map of the Pozo, Santa Ynez quadrangles, scale 1:125,000: 1935. Unpublished. Geologic map of the Caliente area, scale 1″ = 1 mi.: 1935. Unpublished.

Johnston, W. D., Jr., and Cloos, Ernst.

Structural history of the fracture systems at Grass Valley, California: Econ. Geol., vol. 29, 1934, pp. 39-54, figs. 1, 2. (*Fig. 1*—Index map showing intrusive masses in the northern Sierra Nevada Mountains and the location of Grass Valley, scale 11/16″ = 15 mi. *Fig. 2*—Outline map of the Grass Valley quadrangle showing vein outcrops and strike crossings, scale 1 1/16″ = 4000′.)

Jones, William F.

The geology of the Sargent oil field: Univ. Cal. Bull. Dept. Geol. Sci., vol. 6, 1911, pp. 55-78, pl. 18. (Geological map of the Sargent oil field, California. Scale ⅜″ = 500′.)

Kemnitzer, William J.

Geologic map of San Miguel Island, California: California Institute of Technology, 1931. Unpublished.

KK (and **Luis E.**) Geological maps of San Nicolas, and Santa Barbara Islands, scale 1:10,000: California Institute of Technology, 1935. Unpublished.

Kerr, Paul F., and Schenck, Hubert G.

KS25 Active thrust-faults in San Benito County, California: Bull. Geol. Soc. Am., vol. 36, 1925, pp. 465-494, fig. 3. (Generalized diagram of the San Benito area. Scale 1″ = 4 mi.)

Significance of the Matilija overturn: Geol. Soc. Am. Bull. 39, 1928, pp. 1087-1102, fig. 4. (Block diagram of part of Santa Ynez Range.)

Kew, William S. W.

Tertiary echinoids of the Carrizo Creek region in the Colorado Desert: Univ. Cal. Bull. Dept. Geol. Sci., vol. 8, 1914, pp. 39-60, fig. 1. (Map of the southwestern part of the Colorado Desert north of the Mexican boundary line, showing position of the geologic formations. Scale ⅝″ = 10 mi.)

Structure and oil resources of the Simi Valley, southern California: U. S. Geol. Survey Bull. 691, 1918, pp. 323-347, pl. XLI. (Geologic map of Simi Valley, Ventura County, and part of Los Angeles County, California, by W. S. W. Kew and C. M. Wagner. Scale 1:62,500.)

Geology of a part of the Santa Ynez River district, Santa Barbara County, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 12, 1919, 21 pp., pl. 1. (Geologic map of a part of the Santa Ynez River district, Santa Barbara County, California, by W. S. W. Kew after R. Arnold. Scale ¾″ = 1 mi.)

K24 Geology and oil resources of a part of Los Angeles and Ventura Counties, California: U. S. Geol. Survey Bull. 753, 1924, 202 pp., pl. I. (Geologic map of parts of Los Angeles and Ventura Counties, California, by W. S. W. Kew, Carroll M. Wagner, Walter A. English, and John P. Buwalda. Scale 1:62,500.)

K27 Geologic sketch of Santa Rosa Island, Santa Barbara County, California: Bull. Geol. Soc. Am., vol. 38, 1927, pp. 645-658. (Geologic map of Santa Rosa Island, by W. S. W. Kew and C. Bremmer.)

Geologic map of Los Angeles and vicinity, scale 1:250,000. Unpublished.

King, Clarence

Geological and topographical atlas accompanying the report of the geological explorations of the fortieth parallel: U. S. Eng. Dept., 1876, map V. (West half of Nevada Basin. Scale 1″ = 4 mi.)

Kirby, J. M., and Crook, T. H.

Capay Valley formations: *abst.* Pan. Am. Geol., vol. 61, 1934, p. 377. Also unpublished data on the northern Coast Ranges.

Kleinpell, R. M.

Information helpful in grouping the geologic units (especially in the Miocene) of the southern Coast Ranges.

Knopf, Adolph

Mineral resources of the Inyo and White Mountains, California: U. S. Geol. Survey Bull. 540, 1912, pp. 81-120, fig. 6. (Diagrammatic section across Inyo Mountains at Swansea, Cal. Scale ⅛″ = 10,000′.)

Strontianite deposits near Barstow, California: U. S. Geol. Survey Bull. 660, 1917, pp. 257-270, pl. XI. (Reconnaissance map of the Barstow-Kramer region, San Bernardino County, California. Scale 1″ = 4 mi.)

Ka18 A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, California: with a section on the stratigraphy of the Inyo Range, by Edwin Kirk: U. S. Geol. Survey Prof. Paper 110, 1918, 130 pp., pls. I, II. (*Pl. I*—Reconnaissance map of the Bishop quadrangle and a part of the Mt. Goddard quadrangle, California, by A. Knopf, E. Kirk, and F. H. Lahee. *Pl. II*—Geologic reconnaissance map of the Mount Whitney quadrangle and parts of the Olancha and Ballarat quadrangles, by Adolph Knopf, Edwin Kirk, and F. H. Lahee. Scale 1:125,000.)

The Mother Lode system of California: U. S. Geol. Survey Prof. Paper 157, 1929, 88 pp., pl. 2. (Geologic map of the Mother Lode belt, California, reprinted from Folio 63, Geologic Atlas of the United States, with slight modifications, scale 1:63:360, by F. L. Ransome.)

(and **Anderson, C. A.**) The Engels copper deposits, California: Econ. Geol., vol. 25, 1930, pp. 14-35, fig. 1. (Geologic map of the area surrounding the Engels mine. Scale 1¼″ = 3000′.)

KT05 (and **Thelen, P.**) Sketch of the geology of Mineral King, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 4, 1905, pp. 227-262, pl. 30. (Geological map of the Mineral King district. Scale 1″ = 2 mi.)

Lambert, Gerald S.

Geology of a portion of Mt. Hamilton Range, California: Stanford University, 1923. Canada de Pala and adjacent area, scale 1 : 31,250.) Unpublished M. A. thesis.

Larsen, Esper S.

Le Geologic map of the San Luis Rey, Corona (in part), and Elsinore quadrangles, scale 1:125,000: U. S. Geol. Survey, 1935. Unpublished.

Lawson, Andrew C.

The Geology of Carmelo Bay: Univ. Cal. Bull. Dept. Geol. Sci., vol. 1, 1893-96, 59 pp., pl. 1. (Geological map of Carmelo Bay. Scale 2″ = 1 mi.)

Sketch of the geology of the San Francisco Peninsula: U. S. Geol. Survey Ann. Rept. 15, 1895, pp. 399-476, pl. V. (Geological map of the San Francisco Peninsula. Scale 1:113,000.)

The geomorphogeny of the upper Kern basin: Univ. Cal. Bull. Dept. Geol. Sci., vol. 3, 1902-04, pp. 291-376, pl. 31. (Diagram of the upper Kern basin and adjacent mountains. Scale 1:375,000.)

The geomorphogeny of the Tehachapi Valley system: Univ. Cal. Bull. Dept. Geol. Sci., vol. 4, 1906, pp. 431-462, pl. 42. (Physiographic sketch map of the Tehachapi Valley system showing their relation to the Great Valley and to the Mojave Desert. Scale 1″ = 4 mi.)

La14 San Francisco folio; Tamalpais, San Francisco, Concord, San Mateo, and Hayward quadrangles, California (no. 193): U. S. Geol. Survey Geol. Atlas, 1914, 24 pp. (Areal geology sheets. Scale 1:62,500.)

(**Gilbert, G. K., Reid, H. F., Branner, J. C., Leuschner, A. O., Davidson, George, Burckhalter, Charles,** and **Campbell, W. W.**)

Atlas of maps and seismograms accompanying the report of the State Earthquake Investigation Commission upon the California earthquake of April 18, 1906: Carnegie Inst. of Wash., 1908. (25 maps, 15 seismograms.)

(and **Palache, Charles**) The Berkeley Hills, a detail of Coast Range geology: Univ. Cal. Bull. Dept. Geol. Sci., vol. 2, 1900, pp. 349-450. (Geological map of a portion of the Berkeley Hills. Scale 1:12,000.)

Lee, Willis T., Stone, Ralph W., Gale, Hoyt S., and others.

Guidebook of the western United States, Part B., the overland route with a side trip to Yellowstone Park: U. S. Geol. Survey Bull. 612, 1915, 244 pp., sheets 22-25. (Geologic and topographic map of the overland route from Omaha, Nebraska, to San Francisco, California. Scale 1:500,000.)

Lemmon, D. M.

Ld Geologic map of part of the White Mountain quadrangle, scale 1:125,000: Stanford University, 1935. Unpublished.

LR (and **Ransome, A. L.**) Geologic map of the east part of the Mount Morrison quadrangle, scale 1:125,000: Stanford University, 1935. Unpublished.

Lindgren, Waldemar

The silver mines of Calico, California: Trans. Am. Inst. Min. Eng., vol. 15, 1887, pp. 717-734, fig. 6. (Sketch map of Calico district, San Bernardino County, California. Scale 1″ = 1500′.)

The gold-silver veins of Ophir, California: U. S. Geol. Survey Ann. Rept. 14, 1892, pp. 249-284, pl. XVII. (Map of the Ophir and Duncan Hill mining districts, Placer County, California. Scale 1″ = 1400′.)

L94 Sacramento folio, California (no. 5): U. S. Geol. Survey Geol. Atlas, 1894, 3 pp. (Areal geology sheet. Scale 1:125,000.)

L96 Pyramid Peak folio, California (No. 31): U. S. Geol. Survey Geol. Atlas, 1896, 8 pp. (Areal geology sheet. Scale 1:125,000.)

L97 Truckee folio, California (no. 39): U. S. Geol. Survey Geol. Atlas, 1897, 8 pp. (Historical geology sheet. Scale 1:125,000.)

L00 Colfax folio, California (no. 66): U. S. Geol. Survey Geol. Atlas, 1900, 10 pp. (Historical geology sheet. Scale 1:125,000.)

L11 The Tertiary gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, 1911, 226 pp., pls. I, XV. (*Pl. I*—Map of the northern part of the Sierra Nevada, California and Nevada [Markleeville and Sierraville quadrangles], scale 1:750,000. *Pl. XV*—Geologic map of Oroville and Table Mountain, Chico and Marysville quadrangles, Butte County, California, scale 1:125,000.)

LT94 (and **Turner, H. W.**) Placerville folio, California (no. 3): U. S. Geol. Survey Geol. Atlas, 1894, 3 pp. (Areal geology sheet. Scale 1:125,000.)

LT95 (and **Turner, H. W.**) Smartsville folio, California (no. 17); U. S. Geol. Survey Geol. Atlas, 1895, 6 pp. (Areal geology sheet. Scale 1:125,000.)

LT95[1] (and **Turner, H. W.**) Smartsville folio, California (no. 18); U. S. Geol. Survey Geol. Atlas, 1895, 6 pp. (Areal geology sheet. Scale 1:125,000.)

Loel, Wayne

LA (and **Arnold, R.**) Geologic reconnaissance map La Panza quadrangle, California, scale 1:47,500: 1927. Unpublished.

(and **Corey, W. H.**) The Vaqueros formation, lower Miocene of California. I. Paleontology: Univ. Cal. Bull. Dept. Geol. Sci., vol. 22, 1932, pp. 31-410.

Logan, C. A.

Platinum and allied metals in California: Cal. State Min. Bur. Bull. 85, 1918, 120 pp., pl. IV. (Geological map of the central part of Salmon River district, Siskiyou County, California. Scale $\frac{5}{8}$″=1 mi.)

Louderback, George Davis

Various unpublished data.

MacDonald, Donald Francis

Notes on the gold lodes of the Carrville district, Trinity County, California: U. S. Geol. Survey Bull. 530, 1913, pp. 9-41, pl. 1. (Map of portions of Trinity and Siskiyou Counties, California, showing approximately the chief mining locations and the surface geology, by O. H. Hershey and others. Scale 1″ = 4 mi.)

MacGinitie, H.

Notes on Humboldt County: 1931. Unpublished.

Mattei, A. C.

Unpublished notes on geology of the Coast Ranges.

Matthes, François E.

Geologic history of the Yosemite Valley: U. S. Geol. Survey Prof. Paper 160, 1930, 137 pp., pl. 51 (Generalized geologic map of part of the Yosemite region, California. Scale 1:125,000.)

Maxson, John H.

Mj33 Economic geology of portions of Del Norte and Siskiyou Counties, northwesternmost California: State Mineralogist's Rept. 29, 1933, pp. 123-160, pl. IV. (Generalized geological map of northwesternmost California. Scale 1″ = 3 mi.)

May, John C.

Notes in the southern Coast Ranges.

Mayo, Evans B.

Geology and mineral deposits of Laurel and Convict Basins, southwestern Mono County, California: State Mineralogist's Rept. 30, 1934, pp. 79-90, pl. II. (Geologic map of Laurel and Convict Basins, Mono County, California. Scale 1 2/5″ = 1 mi.)

Me Geologic map of southwest Mono County and Sierra Nevada. Unpublished.

McCarthy, M.

Klamath and Smith River watersheds in and adjacent to Klamath National Forest, scale 1:125,000: 1912. Unpublished.

McCollough, E. H.

Kettleman Hills oil field, California: Bull. Am. Assoc. Pet. Geol., vol. 13, 1929, pp. 1479-1483, fig. 1. (Map of Kettleman Hills showing areal geology as mapped by Arnold and Anderson in *U. S. Geol. Survey Bull. 357*, and subsurface geology of the North dome by the writer. Scale ½″ = 2 mi.)

Melcon, Z. K.

Mz Geologic map of the area east of Fresno, scale 1:500,000: Stanford University, 1931. Unpublished M. A. thesis.

Mendenhall, Walter C.

Notes on the geology of Carrizo Mountain and vicinity, San Diego County, California: Jour. Geol., vol. 18, 1910, pp. 336-355, figs. 1, 9. (*Fig. 1*—Sketch map of Carrizo Mountains and vicinity, scale ½″ = 10 mi. *Fig. 9*—Diagrammatic section across Carrizo Mountain by way of Alverson and Garnet Canyons.)

Merriam, John C.

Various geologic data on California.

Miller, William J.

M28 Geology of Deep Spring Valley, California: Jour. Geol., vol. 36, 1928, pp. 510-525, fig. 1. (Geological map of the vicinity of Deep Spring Valley. Scale 5/16″ = 1 mi.)

M31 Geologic section across the southern Sierra Nevada of California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 20, 1931, pp. 331-360, fig. 2. (Geologic map of parts of the Kernville and Searles Lake quadrangles. Scale ⅝″ = 3 mi.)

M34 Geology of the western San Gabriel Mountains of California: Pub. Univ. Cal. at Los Angeles in mathematical and physical sciences, vol. 1, 1934, 114 pp. (Geological map of the western San Gabriel Mountains of California. Scale ¾″ = 1 mi.)

M Pre-Cambrian and associated rocks near Twenty-nine Palms, California: *abst.* Geol. Soc. Am. Pr. 1934 : 99 (1935). Map accompanying.

M35 A geologic section across the southern Peninsular Range of California: State Mineralogist's Rept. 31, 1935, pp. 115-142, pl. II. (Geologic map and sections across southern Peninsular Range San Diego and Imperial Counties, California. Scale 1½″=4 mi.)

Geomorphology of the southern Peninsular Range of California: Bull. Geol. Soc. Am., vol. 46, 1935, pp. 1535-1561, pl. 150. (Topographic and fault map of the southern Peninsular Range of California. Scale 1″=5 mi.)

Mills, James E.

Stratigraphy and succession of the rocks of the Sierra Nevada of California: Bull. Geol. Soc. Am., vol. 3, 1892, pp. 413-444, pl. 13. (Sketch map of pre-Mesozoic and Mesozoic rocks of a portion of the Sierra Nevada, between the North and Middle Forks of Feather River. Scale 1:253,440.)

Miscellaneous:

X Includes also confidential data.

Moore, B. N.

Geologic map of a portion of the Santa Ana Mountains, California: California Institute of Technology. Unpublished.

Murphy, F. Mac

Geology of the Panamint silver district, California: Econ. Geol., vol. 25, 1930, pp. 305-325, fig. 2. (Geologic map of Panamint mining district. Scale ¾″=⅛ mi.)

Mf32 Geology of a part of the Panamint Range, California: State Mineralogist's Rept. 28, 1932, pp. 328-356, pl. IV. (Reconnaissance geologic map of a part of the Panamint Range, California. Scale 1″=2 mi.)

Unpublished data.

Nelson, Richard N.

Nr25 Geology of the hydrographic basin of the upper Santa Ynez River, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 15, 1925, pp. 327-396. (Geologic map of the hydrographic basin of the upper Santa Ynez River, Santa Barbara County, California, after Kew. Scale 1:125,000.)

A contribution to the paleontology of the Martinez Eocene of California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 15, 1925, pp. 397-466, pl. 61. (Geological map of the Eocene and associated formations south of Simi Valley, Ventura County, California. Scale 1⅜″ = 1 mi.)

Noble, L. F.

Borate deposits in the Kramer district, Kern County, California: U. S. Geol. Survey Bull. 785, 1926, pp. 45-61, fig. 13. (Map showing location of principal areas of Tertiary rocks in the region about Kramer, California. Scale 9/16″ = 10 mi.)

Nitrate deposits in southeastern California: U. S. Geol. Survey Bull. 820, 1931, 108 pp., fig. 3. (Sketch map of claims of Messrs. Ratliff and others southwest of Shoshone, California. [Avawatz quadrangle.] Scale 1⅝″ = 2 mi.)

San Andreas Rift north of San Gabriel Mountains, scale 1:500,000: U. S. Geol. Survey, 1934. Unpublished.

Preliminary geologic map of Death Valley region. Unpublished.

Nomland, Jorgen O., and Schenck, Hubert G.

Cretaceous beds at Slate's Hot Springs, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 21, 1932, pp. 37-49, fig. 2. (Sketch map of a part of California showing, in general, the distribution of the rocks assigned to the Franciscan series and the older metamorphic and igneous rocks. Scale 1″ = 6 mi.)

Nutter, Edward Hoit

Sketch of the geology of the Salinas Valley, California: Jour. Geol., vol. 9, 1901, pp. 330-336. (Map showing geology of a part of Monterey County, California. Scale ¾″ = 20 mi.)

Osmont, Vance C.

A geological section of the Coast Ranges north of the Bay of San Francisco: Univ. Cal. Bull. Dept. Geol. Sci., vol. 4, 1904-06, pp. 39-87, pl. 7.

Pack, R. W.

The Sunset-Midway oil field, California: U. S. Geol. Survey. Prof. Paper 116, 1920, 179 pp., pl. II. (Geologic map and sections of the Sunset-Midway oil field, California, and the north flank of the San Emigdio Mountains, by R. W. Pack, Ralph Arnold, H. R. Johnson, W. A. English and R. G. Davies. Scale 1:125,000.)

PE14 (and **English, W. A.**) Geology and oil prospects in Waltham, Priest, Bitterwater, and Peachtree Valleys, California: U. S. Geol. Survey Bull. 581, 1914, pp. 119-160, pl. V. (Geologic map of the Waltham, Priest, Bitterwater, and Peachtree Valleys, in central California. Scale 1:96,000.)

Packard, Earl Leroy

Faunal studies in the Cretaceous of the Santa Ana Mountains of Southern California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 9, 1916, pp. 137-159. (Sketch map of a portion of the Santa Ana Mountains, California, a part of the Corona quadrangle. (Scale ½″ = 1 mi.)

Peacock, Martin A.

P31 The Modoc lava field, northern California: Geog. Rev., vol. 21, 1931, pp. 259-275, fig. 2. (Geological reconnaissance map of the Modoc Lava Field, by Martin A. Peacock and Howard A. Powers. Scale 1:750,000.)

Pike, Ruthven Wedgewood

Geological studies in the Bryson and Cape San Martin quadrangles, California: Stanford University, 1925. (Geologic maps of the Bryson and Cape San Martin quadrangles. Scale 1:62,500.) Unpublished M. A. thesis.

Piper, A. M., Gale, H. S., and Thomas, H. E.

PGT Geology of the Mokelumne River basin, California: U. S. Geol. Survey, Typescript Rept. 1932, 377 pp. (Geologic map of the Mokelumne River basin. Scale 1:52,500.)

Also unpublished reconnaissance maps adjoining on the south.

Post, William S.

Santa Ana Investigation: Cal. State Div. Eng. and Irr. Bull. 19, 1928, 357 pp., map 14. (Santa Ana investigation general map areal geology. Scale 1″ = 4 mi.)

Powers, Howard A.

Ph32 The lavas of the Modoc Lava-Bed quadrangle, California: Am. Mineralogist, vol. 17, 1932, pp. 253-294, pl. I. (Geological reconnaissance map of Modoc Lava-Bed quadrangle, by H. A. Powers and M. A. Peacock. Scale 1:500,000.)

Rand, William W.

Rw31 Preliminary report of the geology of Santa Cruz Island, Santa Barbara County, California: State Mineralogist's Rept. 27, 1931, pp. 214-219. (Geologic map of Santa Cruz Island, California. Scale 1″ = 1 mi.)

Ransome, F. Leslie.

The eruptive rocks of Point Bonita: Univ. Cal. Bull. Dept. Geol. Sci., vol 1, 1893-96, pp. 71-113, pl. 6. (Geological map of Point Bonita. Scale 1½″ = 900′.)

The geology of Angel Island: Univ. Cal. Bull. Dept. Geol. Sci., vol. 1, pp. 193-234, 1893-96, pl. 12. (Geological map of Angel Island. Scale 1 9/16″ = 2000′.)

Some lava flows of the western slope of the Sierra Nevada, California: U. S. Geol. Survey Bull. 89, 1898, 74 pp., pl. II. (Map of a portion of the region drained by the Stanislaus River, California, showing the distribution of the latites and of the associated Neocene volcanic rocks. (Scale 1:125,000.)

Mother Lode district folio, California (no. 63): U. S. Geol. Survey Geol. Atlas, 1900, 11 pp. (Economic geology sheets 1, 2. Scale 1:63,360.)

Also unpublished data.

Reed, R. D.

Information helpful in the grouping of the geologic units (especially in the Pliocene and Pleistocene); contributions to the geology of the Transverse Ranges.

(and **Hollister, J. S.**) Structural evolution of southern California: Bull. Am. Assoc. Pet. Geol., vol. 20, 1936, pp. 1533-1721, pl. 1. (Generalized tectonic map of southern California. Scale 1¼″ = 10 mi.)

Reiche, Parry

Rp Geologic map of the Lucia quadrangle, scale 1:62,500: University of California, 1934. Unpublished.

Reid, John A.

A note on the geology of the Coso Range, Inyo County, California: Jour. Geol., vol. 16, 1908, pp. 64-72, fig. 1. (Sketch map of region surrounding the Coso Range. Scale 1⅛″ = 20 mi.)

The geomorphogeny of the Sierra Nevada northeast of Lake Tahoe: Univ. Cal. Bull. Dept. Geol. Sci., vol. 6, 1911, pp. 89-162, pl. 28. (Geological map of the Tahoe-Carson area. Scale 1:110,000.)

Richards, George L.

Rg Geologic map of the upper Salinas Valley, scale 1″=2 mi: Stanford University, 1934. Unpublished M. A. thesis.

Richardson, Remond W.

Shoreline physiography of the Santa Lucia Mountains: Stanford University, 1923. (Geologic map of the Santa Lucia Range. Scale 1″ = 8 mi.) Unpublished M. A. thesis.

Rumbley, J.

R Geologic map of the north half of the Jamesburg quadrangle, scale 1:62,500: Stanford University, 1930. Unpublished.

Russell, Israel C.

Ri85 Geological history of Lake Lahontan, a Quaternary lake of northwestern Nevada: U. S. Geol. Survey Mono. 11, 1885, 288 pp., pl. XLVI. (Lake Lahontan—a Quaternary lake of northwestern Nevada. Scale 1:760,000.)

Russell, R. Dana

Rd Reconnaissance geologic map of a portion of northern California, scale 6½″ = 30 mi.: University of California, 1931. Unpublished.

(and **VanderHoof, V. L.**) A vertebrate fauna from a new Pliocene formation in northern California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 20, 1931, pp. 11-21. (See Russell, R. Dana, unpublished map of a portion of northern California.)

Russell, Richard Joel

Rj28 Basin range structure and stratigraphy of the Warner Range, northeastern California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 17, 1928, pp. 387-496. (Geological map of Warner Mountains. Scale 1:130,000.)

San Diego State College

SD28 Preliminary report on the geology of the southern half of the Cuyamaca State Park and adjacent districts, San Diego County, California: Delvers Quarterly, vol. 4, July 15, 1936, 28 pp. (Areal geology. Scale 1:62,500.)

Schenck, Hubert G.

Various unpublished data. *See also* Kerr, Paul F.

Sharp, Robert P.

Geologic map of the Ravenna and Lang quadrangles: Harvard University, 1935. Unpublished.

Simpson, Edward C.

Se34 Geology and mineral deposits of the Elizabeth Lake quadrangle, California: State Mineralogist's Rept. 30, 1934, pp. 371-415, pl. V. (Geologic map of Elizabeth Lake quadrangle. Scale 1:125,000.)

Smith, James Perrin

The geologic formations of California, with reconnaissance geologic map: Cal. State Min. Bur. Bull. 72, 1916, 47 pp. (Geological map of the State of California. Scale 1″=12 mi. Reprint 1929. Legend contains 21 geologic units.)

Smith, William Sidney Tangier

S97 The geology of Santa Catalina Island: Proc. Cal. Acad. Sci., ser. 3, vol. 1, 1897, 71 pp., pl. I. (Geological map of Santa Catalina Island. Scale 1:200,000.)

S98 A geological sketch of San Clemente Island: U. S. Geol. Survey Ann. Rept. 18, part II, 1898, pp. 459-496, pl. LXXXIV. (Geological map of San Clemente Island. Scale 1:200,000.)

SMW (**Morse, R. R.**, and **Woodford, A. O.**) Geologic map of San Onofre district, San Luis Rey and San Juan Capistrano quadrangles, scale 1:125,000: Pomona College, 1930. Unpublished.

Soper, E. K., and **Grant, U. S.**

SG Geologic map of the western end of the Santa Monica Mountains. (Dry Canyon, Topanga Canyon, Las Flores, Seminole, Dume Point and Russell Valley quadrangles. Scale 1:24,000.): University of California at Los Angeles, 1934. Unpublished.

Soske, Joshua L.

Salton Sea area vertical magnetic intensity profiles indicating San Andreas fault, scale 1″=5 mi.: California Institute of Technology, 1935. Unpublished.

Southern Pacific Company.

Geology of the Shasta quadrangle (see C. V. Averill). Township plats covering parts of the Chico quadrangle; northeastern Imperial County; northeastern San Diego County; western Riverside County; San Bernardino, western Kern, and northeastern Los Angeles Counties; Amboy quadrangle. Unpublished.

Spurr, Josiah Edward

Descriptive geology of Nevada, south of the fortieth parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, 1903, 229 pp., pl. I. (Geological reconnaissance map of Nevada south of the fortieth parallel, and California compiled from all available information. Scale 1″=15 mi.)

Stalder, Walter

Structural and commercial oil and gas possibilities of central valley region, California: Bull. Am. Assoc. Pet. Geol., vol. 16, 1932, pp. 361-371, fig. 1. (Geologic map of the Marysville Buttes, California. Scale 13/16″ = 15 mi.)

Unpublished data on northern Coast Ranges.

Stanford Geological Survey

Su Geologic maps of Camulos (Piru, Santa Susana, Triunfo, Calabasas), Cholame, Hueneme, Mount Hamilton, Nipomo, Pleasanton, Pozo, Rock Creek, and Salinas quadrangles, and San Joaquin-Miguel Hills area; San Jose, San Juan Bautista, San Luis Rey, Tesla, and Ventura quadrangles.

Stearns, H. T., Robinson, T. W., and Taylor, G. H.

Geology and water resources of the Mokelumne area, California: U. S. Geol. Survey Water-Supply Paper 619, 1930, 402 pp., pl. 2. (Geologic map of the Mokelumne area, California. Scale 1:250,000.)

Steinecke, Max

Unpublished data on the geology of central California.

Stock, Chester, and Bode, Francis D.

SB35 Occurrence of lower Oligocene mammal-bearing beds near Death Valley, California: Proc. Nat. Acad. Sci., vol. 21, 1935, pp. 571-579, pl. I. (Reconnaissance map showing geologic relations of Titus Canyon formations in Grapevine and Funeral Mountains. Scale ⅝″ = 5 mi.)

Stose, George W., and Ljungstedt, O. A.

Geologic map of the United States, scale 1:2,500,000: U. S. Geol. Survey, 1932, 16th International Geol. Congress. (Source of data for California: Manuscript State geologic map, 1:500,000, compiled under direction of G. W. Stose and Olaf P. Jenkins, 1931, from published maps and manuscript maps contributed by geologists, universities, and oil companies of the State—not published.)

Taff, Joseph A.

Geological reconnaissance map of the west side of the Sacramento Valley, scale 1″ = 4 mi.: Associated Oil Company, 1930. Unpublished.

Geology of McKittrick oil field and vicinity, Kern County, California: Bull. Am. Assoc. Pet. Geol., vol. 17, 1933, 15 pp., fig. 1. (Geology of the Temblor Range, California, with enlarged map and geologic section of McKittrick District. Scale ⅝″ = 6 mi.)

Tj35 Geology of Mount Diablo and vicinity: Bull. Geol. Soc. Am., vol. 46, 1935, pp. 1079-1100, pl. 91. (Map and sections of the geology of Mt. Diablo and vicinity. Scale 1¾″ = 4 mi.)

Tj35 Geologic map of the Vacaville-Antioch district, Solano and Contra Costa Counties, scale 1″ = 2 mi.: Associated Oil Company, 1932. Unpublished.

Taliaferro, N. L.

Tn Geologic map of the Salton Sink, west side of the Imperial Valley: University of California, 1910. Unpublished.

Tn (and summer field classes) Geologic maps of the Adelaida, Bryson, Copperopolis, Paso Robles, Piedras Blancas, Nipomo, Cape San Martin, and San Simeon quadrangles, scale 1:62,500: University of California, 1934. Unpublished.

Templeton, E. C.

The geology and stratigraphy of the San Jose quadrangle: Stanford University, 1912. Unpublished M. A. thesis.

Thompson, David G.

The Mohave Desert region, California: U. S. Geol. Survey Water-Supply Paper 578, 1929, 759 pp., pl. 8. (Reconnaissance geologic map of the Mohave Desert region. Scale 1:250,000.)

Tolman, C. F.

Detailed geologic map of the Lone Pine region, scale 1″ = 500′: City of Los Angeles, Bureau of Water Works and Supply, 1927-28. Unpublished.

Geology of upper San Francisco Bay region with special reference to a salt water barrier below confluence of Sacramento and San Joaquin Rivers: Cal. State Div. Water Resources Bull. 28, 1931, 450 pp., pl. D-IX. (Geology of upper San Francisco Bay region in relation to salt water barrier sites. Scale ¾″ = 1 mi.)

Tc Geologic map of Coyote Dam region: Stanford University, 1934. Unpublished.

Trask, Parker D.

Tp26 Geology of Point Sur quadrangle, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 16, 1926, pp. 119-186. (Geologic map of Point Sur quadrangle. Scale 1:62,500.)

Turner, Henry W.

The rocks of Sierra Nevada: U. S. Geol. Survey Ann. Rept. 14, 1892-93, pp. 435-495, pls. XLIX, LV, LVII, LVIII. (*Pl. XLIX*—Geological map of Bear Mountain and vicinity. *Pl. LV*—Geological map of Grizzly Peak, California. *Pl. LVII*—Geological map of Mount Ingalls, California. *Pl. LVIII*—Geological map of Golden Gate Hill and vicinity, California. Scale 1:62,500.)

T94 Jackson folio, California (no. 11): U. S. Geol. Survey Geol. Atlas, 1894, 6 pp. (Areal geology sheet. Scale 1:125,000.)

T97 Downieville folio, California (no. 37): U. S. Geol. Survey Geol. Atlas, 1897, 8 pp. (Historical geology sheet. Scale 1:125,000.)

T98 Bidwell Bar folio, California (no. 43): U. S. Geol. Survey Geol. Atlas, 1898, 6 pp. (Historical geology sheet. Scale 1:125,000.)

T Geologic map of the Yosemite quadrangle, scale 1:125,000: geologic map of a part of the Mt. Lyell quadrangle, scale 1:90,000: U. S. Geol. Survey, 1902. Unpublished.

TR97 (and **Ransome, F. L.**) Sonora folio, California (no. 41): U. S. Geol. Survey Geol. Atlas, 1897, 5 pp. (Historical geology sheet. Scale 1:125,000.)

TR98 (and **Ransome, F. L.**) Big Trees folio, California (no. 51): U. S. Geol. Survey Geol. Atlas, 1898, 8 pp. (Historical geology sheet. Scale 1:125,000.)

Turner, R. E.

TT (and **Taliaferro, N. L.**) Geologic map of the Bradley quadrangle, scale 1:62,500: University of California, 1934. Unpublished.

Vaughan, Francis Edward

V22 Geology of the San Bernardino Mountains north of San Gorgonio Pass: Univ. Cal. Bull. Dept. Geol. Sci., vol. 13, 1922, pp. 319-411. (Geological map of San Bernardino Mountains. Scale 1:125,000.)

Vickery, F. P.

Vf Structural dynamics of the Livermore region, geologic map, scale 1:62,500: Stanford University, 1924. Unpublished Ph.D. thesis.

Wagner, Carroll M., and Schilling, Karl H.

The San Lorenzo group of the San Emigdio region, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 14, 1923, pp. 235-263, pl. 43. (Areal map of a portion of the San Emigdio region, California, showing distribution of the San Lorenzo group. Scale ⅝″ = 1 mi.)

Waring, Clarence A.

Wc14 Petroleum industry of California: Cal. State Min. Bur. map folio accompanying Bull. 69, 1914, pls. II-V. (*Pl II*—Geologic map of portions of Los Angeles and Orange Counties, scale ½″ = 6 mi. *Pl. III*—Geologic map of portions

of Ventura and Los Angeles Counties, scale 1″ = 6 mi. *Pl. IV*—Geologic map of portions of Monterey and San Luis Obispo Counties, scale ½″ = 6 mi. *Pl. V*—Geologic map of portions of San Luis Obispo and Kern Counties, scale ½″ = 6 mi.

Stratigraphic and faunal relations of the Martinez to the Chico and Tejon of Southern California: Proc.. Cal. Acad. Sci., ser. 4, vol. 7, 1917, pp. 41-124, fig. 3. (Geologic map of a portion of Camulos quadrangle after Stanford geological survey in 1910 and notes on the geology north of Santa Susana furnished by R. B. Moran and J. O. Lewis, compiled and altered by C. A. Waring. Scale ¾″ = 2 mi.)

Geological map of Inyo County, California, scale 1¼″ = 5 mi.: Cal. State Min. Bur., 1917.

Waring, Gerald A.

Ground water in the San Jacinto and Temecula basins, California: U. S. Geol. Survey Water-Supply Paper 429, 1919, 113 pp., pl. III. (Map of San Jacinto and Temecula basins, California, showing geologic formations, artesian basins, depths to water, and wells. Scale 1:125,000.)

Weaver, Charles E.

We Geologic map of the Napa, Vacaville, Antioch, Carquinez, Mare Island, Santa Rosa, Petaluma, and Point Reyes quadrangles, scale 1:125,000: U. S. Geol. Survey, 1935. Unpublished.

Webb, Robert W.

Ww Geologic map of the north half of the Kernville quadrangle, scale 1:125,000: University of California at Los Angeles, California Institute of Technology, 1934. Unpublished.

Kern Canyon fault, southern Sierra Nevada: Jour. Geol., vol. 44, 1936, pp. 631-638, fig. 1. (Sketch map showing location of Kern Canyon fault. Scale 13/20″ = 8 mi.)

Williams, Howel

Wh29 Geology of the Marysville Buttes, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 18, 1929, pp. 103-320. (Geologic map of the Marysville Buttes, California. Scale 1:62,500.)

Wh32 Geology of the Lassen Volcanic National Park, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 21, 1932, pp. 195-385. (Geologic map of the Lassen Volcanic National Park, California. Scale 1:48,000.)

Wh32′ Mount Shasta, a Cascade volcano: Jour. Geol., vol. 40, 1932, pp. 417-430. (Geologic sketch map of Mount Shasta. Scale 1″=4 mi.)

Willis, Bailey

A study of the Santa Barbara earthquake of June 29, 1925: Bull. Seis. Soc. Am., vol. 15, 1925, pp. 255-278, pl. 29. (General map of the Coast Ranges from Ventura to San Luis Obispo, showing the principal active faults and the intensities of the earthquake of June 29, 1925, from VII to X on the Rossi-Forel scale.

Central California: Bull. Seis. Soc. Am., vol. 16, 1926, pl. 2. Scale 1:1,000,000.

(and **Wood, H. O.**) Fault map of the State of California, scale 1:506,880: Seis. Soc. Am., 1922.

Willis, Robin

Wr The physiography of the San Andreas fault between the Pajaro Gap and the Cholame Plains (Gonzales, San Benito, Priest Valley, Metz, and Hollister quadrangles); Geological maps, scale 1:62,500, 1:125,000: Stanford University, 1925. Unpublished Ph.D. thesis.

Wilson, R. R.

W Geologic map of the Adelaida quadrangle, California, scale 1:62,500: Stanford University, 1930. Unpublished Ph.D. thesis.

of Ventura and Los Angeles Counties, scale 1″ = 6 mi. *Pl. IV*—Geologic map of portions of Monterey and San Luis Obispo Counties, scale ½″ = 6 mi. *Pl. V*—Geologic map of portions of San Luis Obispo and Kern Counties, scale ½″ = 6 mi.

Stratigraphic and faunal relations of the Martinez to the Chico and Tejon of Southern California: Proc.. Cal. Acad. Sci., ser. 4, vol. 7, 1917, pp. 41-124, fig. 3. (Geologic map of a portion of Camulos quadrangle after Stanford geological survey in 1910 and notes on the geology north of Santa Susana furnished by R. B. Moran and J. O. Lewis, compiled and altered by C. A. Waring. Scale ¾″ = 2 mi.)

Geological map of Inyo County, California, scale 1¼″ = 5 mi.: Cal. State Min. Bur., 1917.

Waring, Gerald A.

Ground water in the San Jacinto and Temecula basins, California: U. S. Geol. Survey Water-Supply Paper 429, 1919, 113 pp., pl. III. (Map of San Jacinto and Temecula basins, California, showing geologic formations, artesian basins, depths to water, and wells. Scale 1:125,000.)

Weaver, Charles E.

We Geologic map of the Napa, Vacaville, Antioch, Carquinez, Mare Island, Santa Rosa, Petaluma, and Point Reyes quadrangles, scale 1:125,000: U. S. Geol. Survey, 1935. Unpublished.

Webb, Robert W.

Ww Geologic map of the north half of the Kernville quadrangle, scale 1:125,000: University of California at Los Angeles, California Institute of Technology, 1934. Unpublished.

Kern Canyon fault, southern Sierra Nevada: Jour. Geol., vol. 44, 1936, pp. 631-638, fig. 1. (Sketch map showing location of Kern Canyon fault. Scale 13/20″ = 8 mi.)

Williams, Howel

Wh29 Geology of the Marysville Buttes, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 18, 1929, pp. 103-320. (Geologic map of the Marysville Buttes, California. Scale 1:62,500.)

Wh32 Geology of the Lassen Volcanic National Park, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 21, 1932, pp. 195-385. (Geologic map of the Lassen Volcanic National Park, California. Scale 1:48,000.)

Wh32′ Mount Shasta, a Cascade volcano: Jour. Geol., vol. 40, 1932, pp. 417-430. (Geologic sketch map of Mount Shasta. Scale 1″=4 mi.)

Willis, Bailey

A study of the Santa Barbara earthquake of June 29, 1925: Bull. Seis. Soc. Am., vol. 15, 1925, pp. 255-278, pl. 29. (General map of the Coast Ranges from Ventura to San Luis Obispo, showing the principal active faults and the intensities of the earthquake of June 29, 1925, from VII to X on the Rossi-Forel scale.

Central California: Bull. Seis. Soc. Am., vol. 16, 1926, pl. 2. Scale 1:1,000,000.

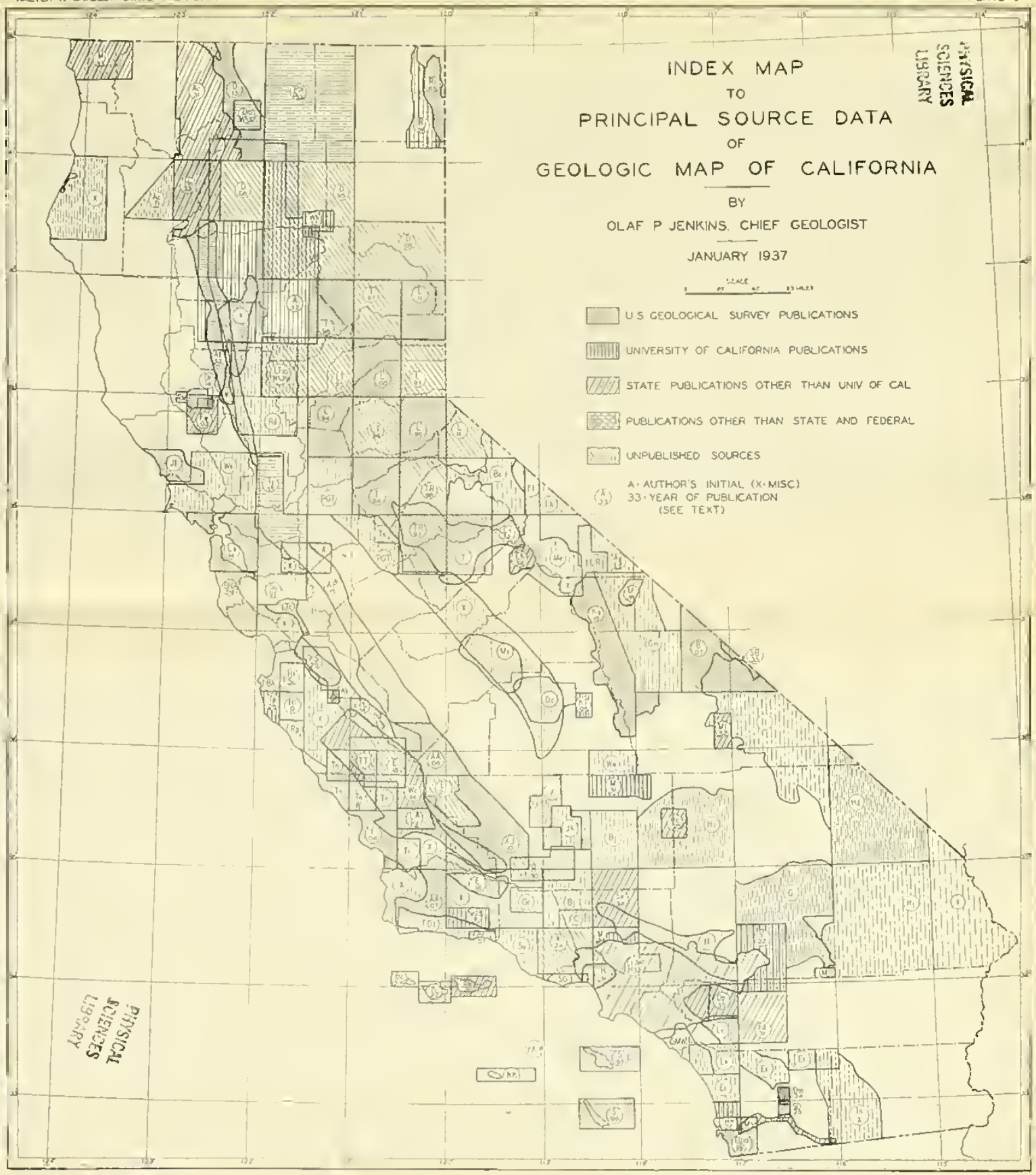
(and **Wood, H. O.**) Fault map of the State of California, scale 1:506,880: Seis. Soc. Am., 1922.

Willis, Robin

Wr The physiography of the San Andreas fault between the Pajaro Gap and the Cholame Plains (Gonzales, San Benito, Priest Valley, Metz, and Hollister quadrangles); Geological maps, scale 1:62,500, 1:125,000: Stanford University, 1925. Unpublished Ph.D. thesis.

Wilson, R. R.

W Geologic map of the Adelaida quadrangle, California, scale 1:62,500: Stanford University, 1930. Unpublished Ph.D. thesis.



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Wood, Harry O.

California earthquakes, a synthetic study of recorded shocks: Bull. Seis. Soc. Am., vol. 6, 1916, pp. 55-180, pl. 3. (Geomorphic map of California and Nevada with portions of Oregon and Idaho. Scale 1″ = 60 mi.)

Woodford, Alfred O.

The San Onofre breccia: Univ. Cal. Bull. Dept. Geol. Sci., vol. 15, 1924-26, pp. 159-280, fig. 2, pls. 23, 24, 35. *Fig. 2*—Map illustrating general distribution of San Onofre breccia, scale 13/16″ = 20 mi. *Pl. 23*—Geologic map of a portion of southern California coast, scale 1⅝″ = 10 mi. *Pl. 24*—Geologic map in the vicinity of San Onofre, scale ⅜″ = ¼ mi. *Pl. 35*—Geological map of the vicinity of Capistrano, California, scale 1″ = 1 mi.)

(and **Harriss, T. F.**) Geology of Blackhawk Canyon, San Bernardino Mountains, California: Univ. Cal. Bull. Dept. Geol. Sci., vol. 17, 1928, pp. 264-292, pl. 36. (Geological map of Blackhawk salient and adjacent portions of the San Bernardino Mountains. Scale 1″ = 2 mi.)

Woodring, W. P.

(**Bramlette, M. N.**, and **Kleinpell, R. M.**) Miocene Stratigraphy and paleontology of Palos Verdes Hills, California: Bull. Am. Assoc. Pet. Geol., vol. 20, 1936, pp. 125-149, fig. 1. (Generalized geologic map of Palos Verdes Hills, California, geology by W. P. Woodring, M. N. Bramlette and W. S. W. Kew. Scale 1:62,500.)

(and **Stewart, Ralph**) Geologic map of the Kettleman Hills, California: U. S. Geol. Survey, advance edition. Scale 1:31,680.)

Yates, Lorenzo G.

Stray notes on the geology of the Channel Islands: State Mineralogist's Rept. 9, 1890, pp. 171-174.

Young, George S.

Y Geologic map of the west side Sacramento Valley, Esperto to Nye Creek, scale 1″ = 2 mi.: 1920. Unpublished.

Young, Walter R.

Report on salt water barrier below confluence of Sacramento and San Joaquin Rivers, California: Cal. State Div. Water Resources Bull. 22, vol. 2, 1929, 131 pp., pls. 3-1, 3-2. (*Pl. 3-1*—Geological map of San Francisco Bay region, after A. C. Lawson, scale 2⅛″ = 20 mi. *Pl. 3-2*—Geological map of Carquinez Strait, after Charles E. Weaver, scale 1:125,000.)

THE GEOLOGY OF QUICKSILVER ORE DEPOSITS.*

By C. N. Schuette**

Quicksilver in the United States has a production history of some 87 years. The annual output has fluctuated tremendously, and quicksilver mining has acquired a reputation of being more hazardous from an economic standpoint than the mining of most other metals. This is probably true, but as in all mining ventures, the risk is balanced by the possibility of great reward, because of the ever-possible discovery of a high-grade orebody.

Two main factors are responsible for the risks encountered in the production of quicksilver. The first of these is the extreme fluctuation in the price for the metal. This factor is largely due to the fact that the supply of the world's quicksilver comes from a few countries only, while all the industrial countries have need of it. Thus this limited supply is subject to speculative control and manipulation.

The second risk factor, which also affects the price, is the irregularity of the orebodies. Even the largest mines in the United States show fluctuations of hundreds of per cent in their monthly output, which, because of the mode of production, is a direct measure of the variability of the orebodies.

This second risk factor, the irregularity of the output of the individual mine, is the result of geological factors governing the deposition of the orebodies. These geological factors are the subject of this paper.

Eight states have contributed to the United States production to date. The output of these eight states since quicksilver production began in the United States some eighty-seven years ago is roughly as follows:

California	2,373,000 flasks	92.0 %
Texas	135,000 flasks	5.2 %
Oregon	32,000 flasks	1.2 %
Nevada	28,500 flasks	1.1 %
Washington	6,500 flasks	0.25%
Utah	3,000 flasks	0.1 %
Arizona	2,000 flasks	0.1 %
Arkansas	1,000 flasks	0.05%
	2,581,000 flasks total	

Thus California is responsible for about 92% of the total United States production, Texas a little over 5%, Oregon and Nevada each a little over 1%, while Washington, Utah, Arizona, and Arkansas together have produced about ½ of 1%.

The preponderance of California's production in these statistics is, I believe, directly related to certain peculiar geological conditions prevailing here at the time of deposition, and I have endeavored to bring out this point in the presentation of this paper.

As I had occasion to visit and work at more and more quicksilver mines in the course of the last 25 years, I became interested in these

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** Consulting Mining Engineer and Geologist, San Francisco.

mines as a group or class, and instead of viewing them as individual ore occurrences, I began to look for group characteristics.

A search of the literature on quicksilver mines was not much help at first because I did not know what to look for, and because great confusion existed in the views of various writers, each of whom tried to explain all quicksilver deposits in terms of the mine or group of mines with which he was most familiar.

No group characteristics, such as the 'iron hat' of copper mines, the Carboniferous age for certain coal deposits, the structural features under which oil is sought, or similar determining factors, had been noted for quicksilver orebodies.

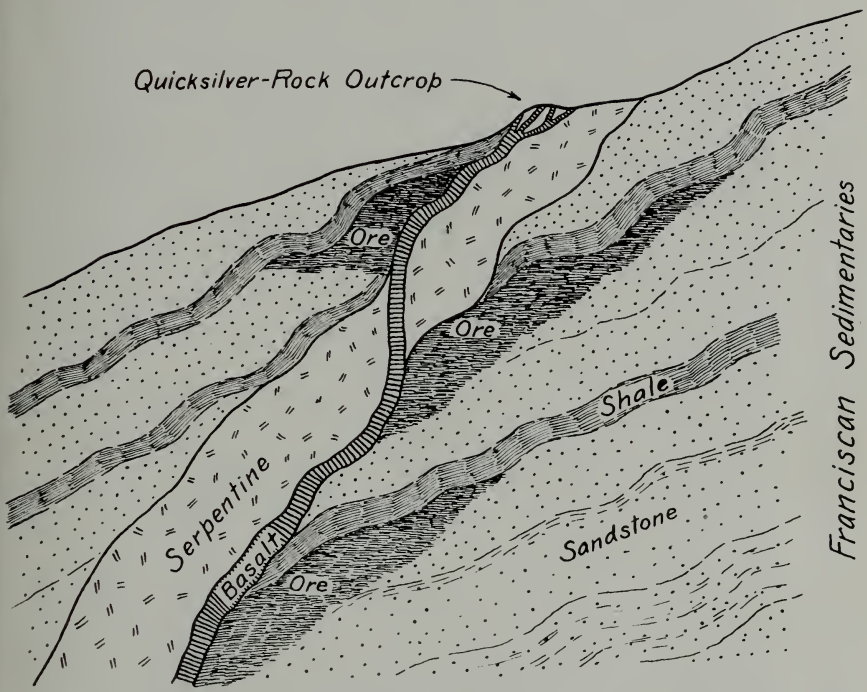

FIG. 1. Vertical section through a typical Californian quicksilver mine. The country rocks are Franciscan sandstones and shales. A sill of serpentine cuts slightly across the stratification. A dike of basalt came up later along the plane of weakness on the serpentine contact. The mineralizing solutions came up along the basalt dike, were trapped under the shale strata, and deposited their load of cinnabar in the sandstone.

Ore deposits are usually thought of as being either primary deposits or secondarily enriched deposits derived from primary mineral deposits. Many primary deposits of mineral, which are not orebodies themselves, were the source of orebodies formed from them by secondary enrichment.

Quicksilver orebodies, I believe, are such a very special case of primary orebodies, that they deserve a separate classification as orebodies formed by a primary enrichment, or better, by a concentration of the primary mineralization during deposition. Orebodies of other metals are formed by this process also, but may and often do form

in other ways, while quicksilver ore deposits are formed *only* by primary enrichment.

The reader should keep in mind that I am discussing only orebodies, a deposit of mineral which can be exploited at a profit. I am not talking about uncommercial mineral occurrences of cinnabar. These may be very interesting geologically and even important as indicators in the search for ore, but they are not the subject of this present discussion.

In my paper *Occurrence of Quicksilver Orebodies,*[1] I set forth 7 general precepts concerning the formation of quicksilver orebodies. They are as follows:

1. The source of the ore is a deep-seated rock magma.

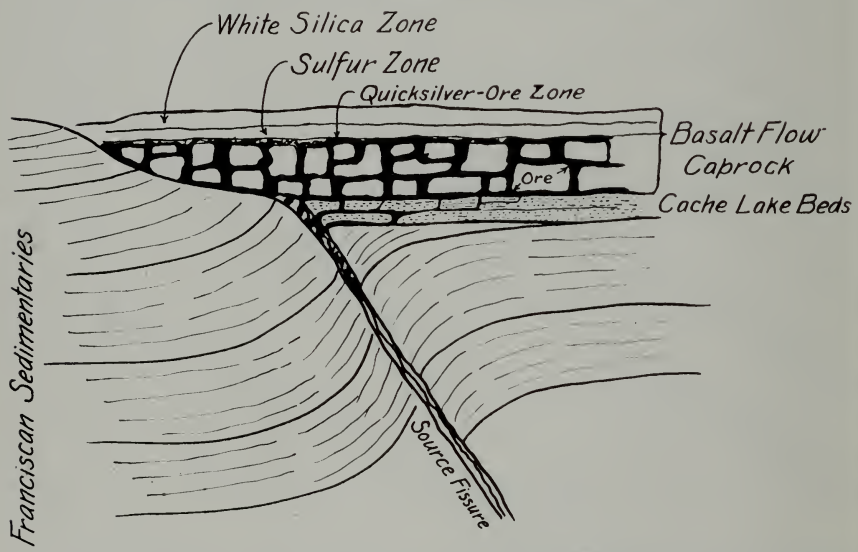

FIG. 2. Vertical section through the Sulphur Bank Mine in Lake Co., California. The source fissure was an east-west fault. Cache (Pleistocene) Lake Beds and a basalt flow capped this fault on the surface. The shrinkage cracks of the cooling basalt flow as well as brecciated rock in the fault zone provided space for deposition of ore. The ore-bearing solutions penetrated to the surface through cracks in the basalt capping. Only white silica is left on the surface. This is the decomposition product of the basalt, as all else was leached out when sulphur vapors combined with oxygen from the air to form acid. Lower down, where the oxygen from the air did not penetrate, sulphur was deposited. The mine was originally worked for this sulphur before the cinnabar under it was discovered.

2. The ore minerals are carried to the point of deposition by hot alkaline solutions ascending through fissures in the rock.
3. The ascending mineral-bearing solutions are directed and limited or even dammed at some point in their upward course by a relatively impervious rock.
4. Precipitation of the ore minerals is caused by cooling and dilution of the mineral-bearing solutions, by loss of pressure or by precipitating agents such as organic matter or gaseous reagents.

[1] Schuette, C. N. Occurrence of quicksilver orebodies: Am. I. M. Eng. Tech. Pub. 335, 1930, 88 pp. Also A.I.M.E. Trans. Vol. 96, 1931 pp. 403-488.

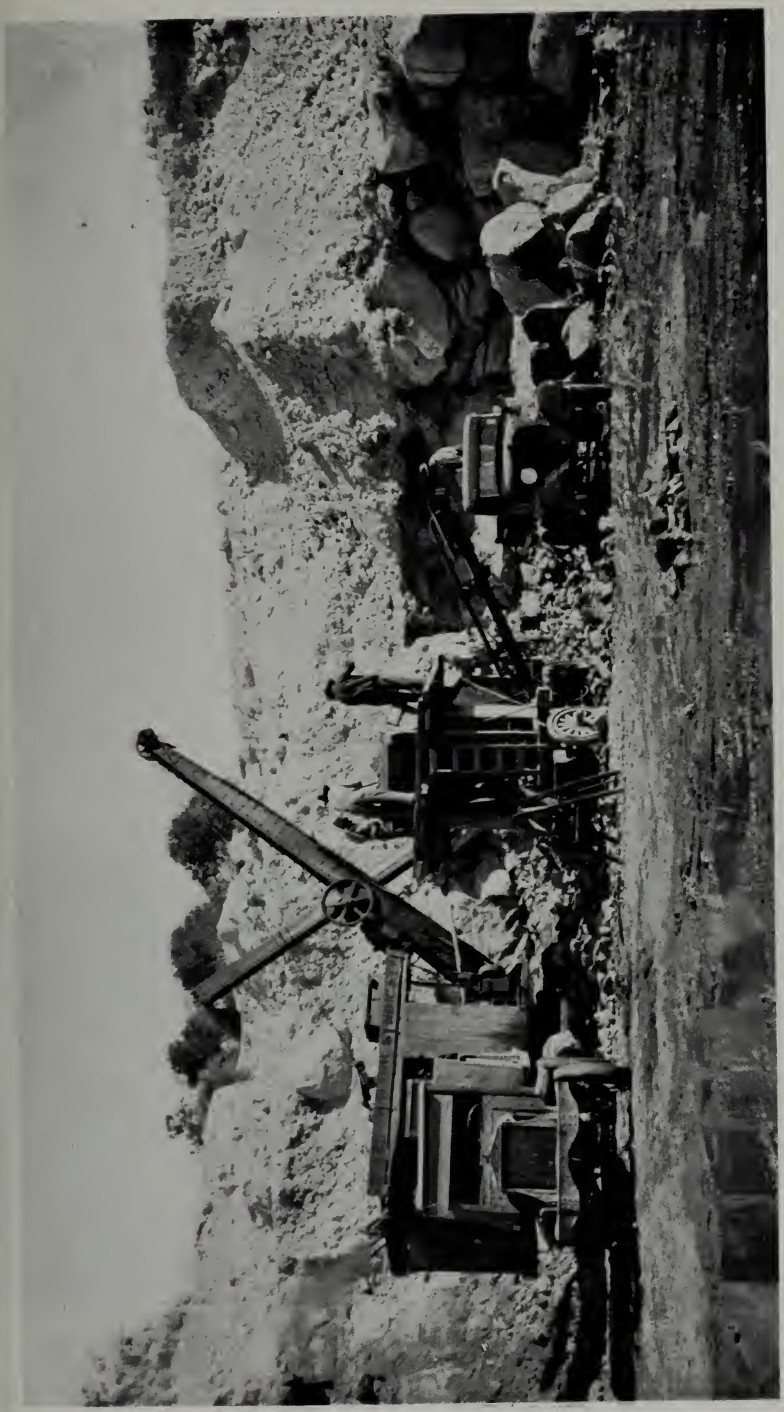

FIG. 3. The Sulphur Bank Mine in operation. Mining is by shovel and the large waste boulders of basalt are sorted out. The machine in the center is a portable screen and the truck at the right is receiving ore from the screen. The 'pillow' structure of the basalt is distinctly visible at the right, as is the sulphur zone and the leached zone above. The floor in the foreground is the Cache Lake beds. Photo by courtesy of Worthen Bradley.

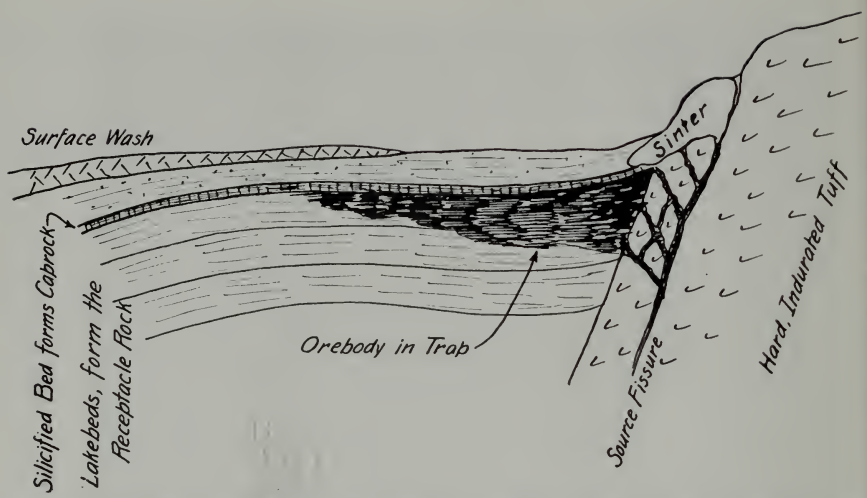

FIG. 4. The Bretz Mine in Malheur Co., Oregon. This belongs in the Nevada or Basin Range province. The hard indurated tuff at the right is an upstanding orogenic block bounded by a steep fault at the left. The sunken block is below the lake beds on the left. The lake beds were deposited in Lahontan times, fairly recently. The fault was the source fissure for quicksilver-bearing solutions which came up while the lake beds were being deposited. Silica accompanied the cinnabar-bearing solutions and built up a sinter deposit as they ran into the lake, and also silicified the beds then forming in the lake. These dense silicified beds formed the cap rock under which the rising solutions concentrated, depositing a body of cinnabar ore. Such of the cinnabar-bearing solutions that rose above the cap rock through fissures in the tuff, ran into the lake and were so diluted that no orebody formed, though these upper lake beds for hundreds of feet around the vents will assay about 1 lb. of quicksilver per ton. The orebody mined from under the cap rock averaged about 20 lbs. of quicksilver per ton.

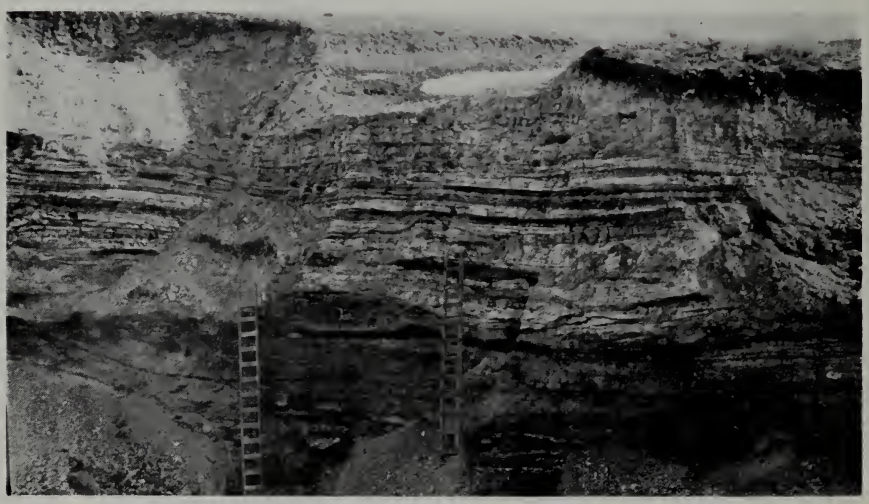

FIG. 5. The Bretz Mine in Oregon. This mine was worked by stripping and mining by shovel. The two dark strata a little way above the highest ladder are the silicified and hence impervious cap rocks that trapped the mineral solutions. Parts of this orebody ran many per cent in grade; the average of all the ore mined was about 1 per cent mercury.

5. The orebody forms in any pervious rock or in the interstitial spaces of any broken rock mass or in other voids underlying the relatively impervious cap rock.
6. The forming of the orebody is due to the concentration of the ore mineral in the trap formed by the relatively impervious rock. This trap structure has directed and limited the upward flow of the mineralizing solutions to the porous rock mass below.
7. The ore minerals are predominantly primary minerals, secondary minerals being rare and of little importance as ore.

These precepts have two logical corollaries:

First, that orebodies formed in this way do not necessarily outcrop hence many such orebodies may remain to be discovered by geological study.

Second, that very high-grade orebodies may be formed in particularly favorable structures.

Let us consider the seven points briefly:

1. *The source of the ore is a deep-seated igneous rock magna:* I think this precept will meet with little opposition, since most primary ores must have a similar origin. Quicksilver deposits the world over show a close association with volcanism and major fractures in the crust of the earth. In some places cinnabar is being deposited today in solfataras. The fact that quicksilver is found and is being deposited in regions where active, or lately active magmas constitute the underlying rocks tends to support this precept. Quicksilver is extremely volatile and logically must be one of the first constituents of a magma to be released.

2. *Alkaline carrier solutions:* Up to about 1878 the prevailing idea regarding the deposition of quicksilver ores was that they had been formed by sublimation.

In that year S. B. Christy[2] read a paper before the Geological Section of the California Academy of Sciences in which he showed that quicksilver ores were more probably deposited from ascending alkaline solutions. Since that time considerable work has been done on this subject by Broderick,[3] and by Allan and Crenshaw,[4] and their laboratory studies have substantiated Christy's work.

3. *Impervious cap rock:* A study of the ore deposits shows that they are always found under a gouge or a cap rock more dense than the receptacle rock in which the ore forms. Shales, fault gouges, dense silicified rocks, and igneous rock in the form of sills in anticlines, constitute the cap rock in different mines that have come under my observation.

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[2] Christy, S. B. On the genesis of cinnabar deposits: Am. Jour. Sci., ser. 3, vol. 17, 1879, pp. 453-463.

[3] Broderick, T. M. Some experiments bearing on the secondary enrichment of quicksilver deposits: Econ. Geol., vol. 11, 1916, pp. 645-651.

[4] Allan, E. T., and Crenshaw, J. L. The sulfides of zinc, cadmium and mercury: Am. Jour. Sci., vol. 34, 1912, pp. 341-396.

4. *Precipitation:* Here again laboratory studies have shown the efficacy of various agents as precipitants; evidence of their work can also be found in the orebodies.

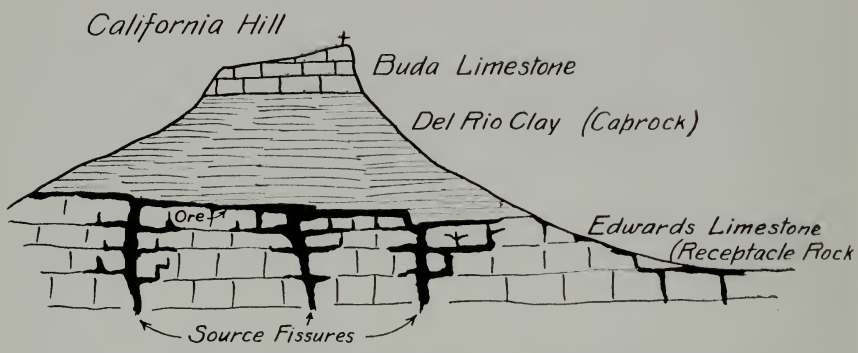

FIG. 6. The Marfa and Mariposa Quicksilver Mine of the Texas province. This was the first producer in Texas. The hill pictured is California Hill; it is capped by a remnant of Buda limestone. Below this is the Del Rio clay, which forms an impervious capping on the Edwards limestone below. The ore formed in fractures and fault breccias of the Edwards limestone, where the ore-bearing solutions were trapped by the dense shales above.

FIG. 7. California Hill in Texas. The rock on top of the hill is Buda limestone. Below that is a great thickness of Del Rio clay. The Edwards limestone shows on the lower slopes of the hill and in the foreground. Dumps from the various levels of the mine can be seen at the right of the photograph.

5. *Receptacle rock:* This merely means that the ore forms in preexisting voids in the rock as against replacement. The voids in the receptacle rock are important, as they govern the grade of the ore. Pore space in sandstone, open fractures in limestone, the interstitial space of breccias, and similar voids furnish lodging for the precipitated cinnabar.

6. *Cap rock:* The effect of the trapping of the mineral-bearing solutions is beautifully illustrated by a study of the ore deposits themselves. The more perfect the trap, the larger and richer the orebody formed under it, provided, of course, that the necessary voids are present.

7. *Primary minerals:* The ore is nearly always cinnabar; where secondary minerals are found they could in all cases have been formed subsequent to the primary mineralization by surface agencies, and were no doubt so formed.

Having mentioned primary and secondary quicksilver minerals it might be well at this point to speak of the quicksilver minerals in general.

The ore of quicksilver is the red sulphide, cinnabar. There are some 25 minerals containing quicksilver, but it is safe to say that 99% of the U. S. production, or world production, for that matter, has come from cinnabar. Many of the 25 quicksilver minerals are very rare and are only found as occasional specimens. Those minerals other than cinnabar which the quicksilver miner may encounter are metacinnabar, native quicksilver, livingstonite, montroydite, calomel, and the oxychlorides terlinguaite and eglestonite. These last four are commonly reported as occurring in Texas only, but I have found them in California, Nevada, and Oregon mines as well.

These minerals are all secondary minerals formed close to the surface of the orebodies by surface agencies. While cinnabar is the primary ore, secondary cinnabar is also occasionally found near the surface. We often find cinnabar that, because of its mode of occurrence, its appearance, and its association with other gangue minerals, makes us very certain that it is secondary. It does not, however, form secondary enrichment deposits, as, for example, those formed in copper mines. This is because the precipitating agents are present in the same horizon as the agents of solution, and there is not the migration before precipitation that results in enrichments. Livingstonite is either a mechanical mixture, or a chemical compound of antimony and quicksilver sulphides.

How these secondary minerals are formed has also been demonstrated in the laboratory work of Broderick and Allan and Crenshaw. This work shows that:

1. Cinnabar is soluble in alkaline solutions, and increased pressure increases the solubility.

2. It can be precipitated from such solutions by cooling, by loss of pressure, and by precipitating agents that could be present during the deposition of an ore deposit, i.e., gases and organic matter.

3. Primary cinnabar can be dissolved by acid surface waters, and native quicksilver can be precipitated from these acid solutions by the combined action of H_2S and organic matter.

4. Metacinnabar can similarly be formed by solution of primary cinnabar by surface acid waters and precipitation with H_2S.

5. Cinnabar can be dissolved by surface chloride waters.

6. Such chloride waters in contact with certain sulphides, e.g. stibnite, will precipitate mercuric sulphide. This is the reaction underlying the formation of livingstonite.

7. Calomel, metacinnabar, and native quicksilver can be precipitated from surface chloride solutions by reducing gases and H_2S from organic matter.

8. Contact of such solutions with calcite can precipitate the oxychlorides, and if ferrous sulfate is present, calomel is formed by the reduction.

Fig. 8. Underground in a Texas quicksilver mine. These mines are in limestone and no timber is needed to support the back. Immense open stopes and large natural caves are features of these mines that center around the town of Terlingua in Brewster County, Texas.

9. Native quicksilver can also be formed by the decomposition of the less-stable chloride and oxide; in nature it is often found in small globules in these minerals.

Thus the manner in which all the commonly-found quicksilver minerals are formed is fairly well known and has been confirmed by laboratory experiments.

Another mineral, though not a quicksilver mineral, is often found with the primary cinnabar. This is the famous bitumen, a hydrocarbon of varying composition. Some geologists seem to think that it

must also have a magmatic origin; however, we must remember that the rocks through which the quicksilver solutions rose were sediments containing organic matter. The heat attending the rising solutions no doubt causes distillation of this organic matter. The distillate rises in the same fissure as the ore-bearing solutions, and is trapped under the same gouges as the cinnabar. This, I think, is a more probable explanation of its occurrence than one which necessitates a magmatic origin.

Let us now consider three typical but different quicksilver mining provinces. These can be called the California province, the Nevada or Basin Range province, and the Texas province.

In California most of the quicksilver mines, and certainly all the large ones, are found in the Franciscan formation. This, which is

FIG. 9. A square-set stope in the Great Western quicksilver mine in Lake County, California. Here the orebodies lie irregularly in broken ground under gouges, and square-setting is needed both to support the back and to follow the ore.

Jurassic in age, consists predominantly of sandstones and shales with smaller strata of radiolarian cherts and a few limestone lenses and glaucophane schists. The sediments are intercalated with lava flows and old intrusives generally referred to as greenstones.

After the sediments were laid down and intruded a further period of upheaval occurred, and intrusions of peridotite in the forms of sills and dikes took place over large areas. The general trend of the major rifts and faults through which the peridotites came up was NW and SE. These peridotites, which we now find altered to serpentine, appear to be intrusive into the Franciscan only. After this there seems to have been an erosional interval during which the peridotites at least initiated their change to serpentine as we find them today. This change, during which water is absorbed, causing an increase in volume estimated to be about 25%, caused crushing and crumbling and local faulting along the contact zones. Then upper Jurassic, followed by Cretaceous and other younger beds were laid down.

At a later date, perhaps in the Pleistocene, another period of volcanic activity in the region of the Franciscan rocks resulted in their intrusion by basalts, diabases, and similar igneous rocks. These rocks in general came up through planes of weakness previously established by the peridotites, that is, generally along the contacts of the sandstone

FIG. 10. Glory Hole at the Mt. Diablo quicksilver mine in Contra Costa County, California. The hole in the right foreground contained an orebody in fault breccia under a gouge that yielded better than a flask of quicksilver per ton.

or shale and the serpentine. As these later dikes and sills cooled they either gave off or gave passage to hot alkaline solutions, from which the cinnabar was deposited. Hence it is that we have so many quicksilver deposits on the contact between serpentine and the Franciscan sedimentaries. Hence also we have those famous quicksilver-rock outcrops

which were first described by Knopf[5]. The silica-carbonate rock, a hydrometamorphosed alteration product of serpentine, is formed by solutions highly charged with carbon dioxide and carrying calcium carbonate and metallic sulphides. Where silica is abundant near the outcrop it forms a hard, cavernous, irregular mass of spongy brown limonite honeycombed with silica. At other points silica is less abundant; here the rock is soft. and does not outcrop prominently.

This description fits the rock perfectly whether it be found in Santa Barbara County, San Luis Obispo County, Santa Clara County, Lake County, or any other place that quicksilver mines occur on a serpentine-sandstone contact.

The Franciscan rocks are tremendously folded, faulted, and crushed, and for this reason most geologists give them a wide berth. Their maps generally show Cretaceous and younger formations beautifully delineated, with all dips and strikes shown, surrounding a detailless blob of rock designated simply as 'Franciscan metamorphics.' Within this complicated 'blob 'the quicksilver miner struggles valiantly to untangle the puzzle of such structure as he can decipher, for it is here, in this ground that has been prepared for him by ages of contortion and faulting, that he finds the traps in which the quicksilver-bearing solutions were caught to form his orebodies. The contortion and faulting made both the breccias that furnished the receptacle rock for the ore deposition and the fault gouges that capped them. The gouge-cap prevented the quicksilver solutions from escaping to the surface; otherwise they would have been diluted by meteoric waters, and lost, so far as concentration sufficient to make orebodies is concerned.

In Nevada we have an area comparable in size to that of California; its quicksilver mineralization is every bit as widespread as that in the Franciscan of California. In Nevada. however, east of the Sierra Nevada and Cascade ranges generally, we have a typical basin range structure. The quicksilver-bearing solutions came up the large deep boundary faults of the orogenic blocks, reached the surface quickly, had less breccia to form in and many less gouges to be trapped under; therefore, the Nevada quicksilver mines are small in total tonnage, generally shallow, and mostly confined to small areas. The territory lacked the long preparation which the Franciscan of California underwent to make it so nearly perfect a depository for quicksilver ore.

Texas, where production started about 40 years ago, has an area in the Big Bend country which can be said to have geological features making for a regional concentration of cinnabar. The rocks are upper and lower Cretaceous limestones, shales, and clays cut by intrusive dikes and intercalated with sills of intrusive rocks. It is a solfataric region similar to California and Nevada, as evidenced by numerous hot springs.

Some ore is found in thin-bedded shaly limestones and under igneous sills in the Taylor marl, Austin chalk, and Eagle Ford formations of the Upper Cretaceous, and in the Buda limestone of the Lower Cretaceous; but the most productive horizon is just under the Del Rio clay (the impervious cap rock) lying on the Edwards limestone of the Lower Cretaceous. Incidentally, many of the Mexican quicksilver

[5] Knopf, A. An alteration of Coast Range serpentine. Univ. Cal. Bull. Dept. Geol. Sci., vol. 4, 1906, pp. 425-430.

deposits occur in similar manner in the Cretaceous rocks which extend across from Texas through several Mexican states.

There are few large quicksilver mines in the world. Almaden in Spain, Idria in what was formerly Austria, Monte Amiata in Italy, and Huancavelica in Peru are the largest outside the United States. Each presents a perfect trap structurally, and each was the one and only really large mine in its region.

FIG. 11. The McCoy quicksilver mine in central Nevada. Here a dense, silicified, flat-dipping, fossiliferous limestone forms the cap rock, and a sandstone lies under it. The ore is concentrated on the limestone-sandstone contact, and extends down into vertical fissures in the sandstone. Very high grade ore has been found in leached-out pockets on the under part of the limestone.

Only in California where geologic events produced the almost perfect type of structure for the formation of quicksilver orebodies by a concentration of the primary mineralization during deposition, and where geologic events produced such structures over an area covering half the state, can one cite so many large mines as our New Almaden, New Idria, Oathill, Sulphur Bank, Knoxville, Great Western, Guadalupe, Aetna, Altoona, Oceanic, Great Eastern, and Mirabel, beside the many dozens of smaller mines.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From October 4, 1936, to and including January 2, 1937, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
King-McCray Oil Co.	14	20 S.	14 E.	Gralan 2	Coalinga
Section Thirty Oil Co.	30	19 S.	15 E.	4	Coalinga
J. A. Tyler	14	20 S.	14 E.	3	Coalinga
John F. Wilcox	11	20 S.	14 E.	5	Coalinga
Kettleman North Dome Assoc.	20	21 S.	17 E.	25	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	36	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	65	Kettleman North Dome
Kettleman North Dome Assoc.	34	21 S.	17 E.	32	Kettleman North Dome
Kettleman North Dome Assoc.	4	22 S.	17 E.	61	Kettleman North Dome
Standard Oil Co.	19	21 S.	17 E.	8	Kettleman North Dome
Standard Oil Co.	19	21 S.	17 E.	85	Kettleman North Dome
Mohawk Petroleum Co.	30	16 S.	15 E.	Langdon 1	Kettleman North Dome
HUMBOLDT COUNTY:					
Walter W. Eich	21	4 N.	1 W.	3	----------
KERN COUNTY:					
Belridge Oil Co.	27	27 S.	20 E.	62-27	Belridge
Belridge Oil Co.	35	27 S.	20 E.	14-35	Belridge
Long and Associates	20	25 S.	19 E.	1	Devils Den
Lube Oil Co.	2	25 S.	18 E.	Gordon 1	Devils Den
Berry Holding Co.	10	30 S.	29 E.	Grayson 4	Edison
Manfield Oil Co.	24	30 S.	29 E.	Smithwick 1	Edison
California Star Oil Co.	21	29 S.	27 E.	Moore 2	Fruitvale
Harr & White	26	29 S.	27 E.	Harr & White Ticehurst 1	Fruitvale
Paul L. Kelley	23	29 S.	27 E.	Greely 1	Fruitvale
Meridian Oil Co.	23	29 S.	27 E.	Dixon 1	Fruitvale
Standard Petroleum Corp.	28	29 S.	27 E.	Scheel 2	Fruitvale
Tarr & McComb Oil Co., Ltd.	23	29 S.	27 E.	Fairhaven 4	Fruitvale
Western Gulf Oil Co.	14	29 S.	27 E.	Galtes 1	Fruitvale
Western Gulf Oil Co.	21	29 S.	27 E.	Brockman 1	Fruitvale
Western Gulf Oil Co.	21	29 S.	27 E.	Fisher 1	Fruitvale
Western Gulf Oil Co.	22	29 S.	27 E.	23-KCL-B	Fruitvale
Western Gulf Oil Co.	22	29 S.	27 E.	24-KCL-B	Fruitvale
H. L. Whiston	23	29 S.	27 E.	Turner 1	Fruitvale
American Exploration Co.	16	28 S.	27 E.	Cauley 2	Kern River
Bishop Oil Co.	23	28 S.	27 E.	9	Kern River
Bishop Oil Co.	23	28 S.	27 E.	10	Kern River
Bishop Oil Co.	23	28 S.	27 E.	11	Kern River
California Star Oil Co.	22	28 S.	27 E.	7-40	Kern River
General Petroleum Corp.	14	28 S.	27 E.	Wetmore 15	Kern River
General Petroleum Corp.	14	28 S.	27 E.	Young 37	Kern River
General Petroleum Corp.	14	28 S.	27 E.	Young 42	Kern River
Italo Petroleum Corp.	16	28 S.	27 E.	Cauley 34	Kern River
Italo Petroleum Corp.	16	28 S.	27 E.	Cauley 35	Kern River
Alvah M. Kaime	17	28 S.	27 E.	Seskayden-Sesnon 2-A	Kern River
Thos. W. McManus	2	29 S.	28 E.	Tom McManus 1	Kern River
E. B. Milburn	10	28 S.	27 E.	1	Kern River
National Oil Co.	11	28 S.	27 E.	Grau 5	Kern River
National Oil Co.	11	28 S.	27 E.	Universal 3	Kern River
National Oil Co.	11	28 S.	27 E.	Universal 4	Kern River
Tide Water Associated Oil Co.	34	28 S.	28 E.	Reed Crude 11	Kern River
M. W. Whittier Co., Ltd.	16	28 S.	27 E.	Cauley 3	Kern River
Standard Oil Co.	2	26 S.	20 E.	United 2	Lost Hills
Tide Water Associated Oil Co.	11	26 S.	20 E.	Elliott 8-A-3	Lost Hills
Tide Water Associated Oil Co.	11	26 S.	20 E.	Williamson 10-A-3	Lost Hills
Welport Oil Co.	26	29 S.	21 E.	16	McKittrick
C. C. M. O. Co.	21	32 S.	23 E.	21	Midway
C. C. M. O. Co.	21	32 S.	23 E.	24	Midway
C. C. M. O. Co.	21	32 S.	23 E.	25	Midway
C. C. M. O. Co.	21	32 S.	23 E.	33	Midway
C. C. M. O. Co.	21	32 S.	23 E.	J-1	Midway
Crawford & Co., Ltd.	15	31 S.	22 E.	Crawford 1	Midway
D. D. Dunlap Oil Co.	15	32 S.	23 E.	15-1	Midway
General Petroleum Corp.	24	31 S.	23 E.	Balboa 49	Midway
General Petroleum Corp.	32	32 S.	24 E.	6	Midway
Frank Goldman	22	32 S.	23 E.	Keene 4	Midway
Frank Goldman	22	32 S.	23 E.	Keene 5	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	16	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	17	Midway

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued					
R. McCray	22	32 S.	23 E.	R. McCray 1	Midway
R. McCray	22	32 S.	23 E.	R. McCray 2	Midway
North American Oil Cons.	2	32 S.	24 E.	4	Midway
Quality Oil Co.	22	32 S.	23 E.	Cypress 3	Midway
Quality Oil Co.	27	32 S.	23 E.	W. P. 4	Midway
South Cerritos Oil Co.	22	32 S.	23 E.	South Cerritos 3	Midway
South Cerritos Oil Co.	22	32 S.	23 E.	South Cerritos 4	Midway
Standard Oil Co.	3	32 S.	24 E.	28	Midway
Standard Oil Co.	33	32 S.	24 E.	53	Midway
Surprise Oil Co.	36	32 S.	23 E.	6	Midway
The Texas Co.	32	32 S.	24 E.	17	Midway
Tide Water Associated Oil Co.	35	31 S.	22 E.	61-A	Midway
Union Oil Co.	22	32 S.	23 E.	Keene 4	Midway
Union Oil Co.	22	32 S.	23 E.	Keene 6	Midway
Union Oil Co.	22	32 S.	23 E.	Williams 3	Midway
Union Oil Co.	22	32 S.	23 E.	Williams 4	Midway
C. C. M. O. Co.	26	27 S.	28 E.	Mon 3	Mt. Poso
R. S. Lytle	26	27 S.	28 E.	Dorsey 5	Mt. Poso
Petroleum Securities Co.	26	27 S.	28 E.	Gardner 6	Mt. Poso
Petroleum Securities Co.	34	27 S.	28 E.	Murdoch 2	Mt. Poso
Ring Oil Co., Ltd.	29	26 S.	28 E.	29-Bowles 1	Mt. Poso
The Texas Co.	4	27 S.	28 E.	Alta Vedder 11	Mt. Poso
Transit Oil Co.	33	27 S.	28 E.	Transit Glide 1	Mt. Poso
Vanguard Oil Co.	33	27 S.	28 E.	Baker 6	Mt. Poso
Buffalo Oil Co.	19	30 S.	29 E.	Buffalo 5	Mountain View
Buffalo Oil Co.	19	30 S.	29 E.	Buffalo 6	Mountain View
General Petroleum Corp.	19	30 S.	29 E.	Feeport 1	Mountain View
Hillman-Long, Inc.	34	30 S.	29 E.	Whittekin 1	Mountain View
Hogan Petroleum Co.	29	30 S.	29 E.	Porter-Day 9	Mountain View
Hogan Petroleum Co.	4	31 S.	29 E.	Symons-Bankline 2	Mountain View
The Ohio Oil Co.	33	30 S.	29 E.	Derby B-1	Mountain View
Standard Oil Co.	13	30 S.	28 E.	Calif.Lands, Inc. 3	Mountain View
Standard Oil Co.	18	30 S.	29 E.	Mabry 3	Mountain View
Trico Oil and Gas Co.	13	30 S.	28 E.	Wilson 1	Mountain View
Wood-Callahan Oil Co., Ltd.	24	30 S.	28 E.	Mullaney 2	Mountain View
Alphonzo E. Bell Corp.	14	27 S.	27 E.	Fitzhugh 3	Poso Creek
California Western Oil Co., Ltd.	23	27 S.	27 E.	2	Poso Creek
Cedar Oil Co.	8	28 S.	27 E.	Gill 1	Poso Creek
C. C. M. O. Co.	35	27 S.	27 E.	CCMO Co. 1	Poso Creek
Warren Deuel	28	27 S.	27 E.	2	Poso Creek
Framac Oil Co.	22	27 S.	27 E.	Brown 3	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	48	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	49	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	59	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	68	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	69	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	79	Poso Creek
Honolulu Oil Corp., Ltd.	8	28 S.	27 E.	88	Poso Creek
Jeffries Petroleum Co.	7	27 S.	27 E.	Carter 1	Poso Creek
Roscoe and Stanley	29	27 S.	27 E.	Roscoe-Stanley-New Hope 1	Poso Creek
Roscoe and Stanley	29	27 S.	27 E.	Roscoe-Stanley-New Hope 2	Poso Creek
Standard Oil Co.	9	28 S.	27 E.	2	Poso Creek
California Western Oil Co., Ltd.	7	28 S.	29 E.	18	Round Mountain
California Western Oil Co., Ltd.	7	28 S.	29 E.	19	Round Mountain
California Western Oil Co., Ltd.	7	28 S.	29 E.	20	Round Mountain
C. C. M. O. Co.	6	28 S.	29 E.	7	Round Mountain
Shamrock Petroleum Corp.	6	28 S.	29 E.	Shamrock 6	Round Mountain
Shell Oil Co.	7	28 S.	29 E.	Caldwell 16	Round Mountain
Shell Oil Co.	20	28 S.	29 E.	Freeman 12	Round Mountain
Continental Oil Co.	8	27 S.	24 E.	K. C. L. A-1	Semitropic Gas
Alford Oil Co.	25	12 N.	24 W.	Fried 7	Sunset
Berry Oil Co.	28	12 N.	24 W.	23	Sunset
Five Points Petroleum Corp.	18	11 N.	23 W.	Lease Two 2	Sunset
Five Points Petroleum Corp.	18	11 N.	23 W.	Lease Two 3	Sunset
General Petroleum Corp.	34	12 N.	24 W.	Moco 34 172	Sunset
Gibson Oil Co., Inc.	6	11 N.	23 W.	Blanck 2	Sunset
Gibson Oil Co., Inc.	6	11 N.	23 W.	O'Brien 4	Sunset
Otis Hoyt	7	11 N.	23 W.	Otis Hoyt Maricopa 4	Sunset
Merritt Annex Oil Co.	25	12 N.	24 W.	Fried 2	Sunset
Merritt Annex Oil Co.	25	12 N.	24 W.	Fried 3	Sunset
Oil Incorporated	7	11 N.	23 W.	O 2	Sunset
Oil Producers, Inc.	7	11 N.	23 W.	1	Sunset
Twentieth Century Oil Co.	1	11 N.	24 W.	5	Sunset
Shell Oil Co.	29	30 S.	26 E.	KCL-A 34-29	Ten Section
Shell Oil Co.	30	30 S.	26 E.	KCL-A 78-30	Ten Section

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued					
British-American, Inc.	21	31 S.	27 E.	Smith 1-A	
99 Oil Co.	5	10 N.	19 W.	99 1	
Reserve Oil and Gas Co.	33	11 N.	19 W.	33-3	
Trans-Line Petroleum Corp.	3	10 N.	23 W.	1	
KINGS COUNTY:					
Tide Water Associated Oil Co.	35	23 S.	17 E.	Avenal 2	
LOS ANGELES COUNTY:					
Shell Oil Co.	33	3 S.	13 W.	Reyes 87	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 88	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 89	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 48	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 52	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 53	Dominguez
Union Oil Co.	33	3 S.	13 W.	Carson 9	Dominguez
The Caminol Co., Ltd.	18	3 S.	14 W.	Caminol-El Segundo 1	El Segundo
The Ohio Oil Co.	7	3 S.	14 W.	A. S. Gough 2	El Segundo
Republic Petroleum Corp.	18	3 S.	14 W.	Republic-El Segundo 3	El Segundo
Republic Petroleum Corp.	18	3 S.	14 W.	Republic-El Segundo 4	El Segundo
Richfield Oil Co.	18	3 S.	14 W.	El Segundo 2	El Segundo
The Texas Co.	17	3 S.	14 W.	Johnson Two 1	El Segundo
Standard Oil Co.	8	2 S.	14 W.	L. A. Investment Lease 81	Inglewood
Hobbs Petroleum	30	4 S.	12 W.	Bass & Good-knight 6	Long Beach
Richfield Oil Co.	5	2 S.	11W.	Nutt 2	Montebello
The St. Helens Petroleum Co., Ltd.	2	2 S.	12 W.	Monterey 22	Montebello
The St. Helens Petroleum Co., Ltd.	2	2 S.	12 W.	Monterey 23	Montebello
Standard Oil Co.	1	2 S.	12 W.	Baldwin 90	Montebello
Union Oil Co.	27	2 S.	15 W.	Del Rey 15	Playa del Rey
Union Oil Co.	27	2 S.	15 W.	Del Rey 16	Playa del Rey
General Petroleum Corp.	5	3 S.	11 W.	Santa Fe 43-C	Santa Fe Springs
Black Gold Corp.	6	4 S.	14 W.	Black Gold 2	Torrance
Dumas-Lewis Oil Co.	6	4 S.	14 W.	Dumas-Lewis 3	Torrance
Keystone Consolidated Oil Co.	8	4 S.	14 W.	Lupin 1	Torrance
Frans Nelson Petroleum Co. No. 2	18	4 S.	14 W.	2	Torrance
Southwest Petroleum Corp.	6	4 S.	14 W.	Redondo 1	Torrance
N. H. Cayton	22	2 S.	11 W.	1	Whittier
Drillers, Inc.	22	2 S.	11 W.	1	Whittier
Bankline Oil Co.	33	4 S.	13 W.	Pacific Terminal Comm. 22	Wilmington
Bankline Oil Co.	33	4 S.	13 W.	Watson Seven 1	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Terminal 2	Wilmington
General Petroleum Corp.	5	5 S.	13 W.	Patton 1	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W 1	Wilmington
C. W. Long	27	4 S.	13 W.	L. A. 1	Wilmington
Royalty Service Corp., Ltd.	5	5 S.	13 W.	Community 1	Wilmington
Selegna Oil Co.	28	4 S.	13 W.	Menveg 1	Wilmington
Sunset Oil Co.	28	4 S.	13 W.	Lupie 3	Wilmington
Charter Oak Oil Co., Ltd.	7	1 S.	9 W.	Charter Oak 1	
Honolulu Oil Corp., Ltd.	15	2 S.	10 W.	Butler 1	
Honolulu Oil Corp., Ltd.	14	2 S.	12 W.	Montebello 1	
C. A. Julian and D. W. Criswell	5	2 S.	9 W.	Koch Comm. 1	
Shell Oil Co.	20	3 S.	13 W.	McKinley 4-1	
Shell Oil Co.	11	4 S.	13 W.	Flood Control 1	
Southern California Drilling Co.	2	5 S.	14 W.	Burkhard 1	
Standard Oil Co.	22	3 S.	14 W.	Bodger 1	
MONTEREY COUNTY:					
Amil A. Anderson	15	24 S.	14 E.	Hillman 1	
The Texas Co.	30	19 S.	7 E.	Dunphy 1	
NAPA COUNTY:					
Lincoln & Kuhns	29	8 N.	3 W.	2	
Lincoln & Kuhns	29	8 N.	3 W.	3	
ORANGE COUNTY:					
Bandini Petroleum Co.	17	3 S.	9 W.	Kammerdiner 1	Coyote Hills
Bartholomae Oil Corp.	22	3 S.	10 W.	Stern 4	Coyote Hills
Graham- Loftus Oil Corp.	18	3 S.	9 W.	Perkins 1	Coyote Hills
Oil Conservation, Ltd.	17	3 S.	9 W.	Jessup 1	Coyote Hills
V. R. G. Wilbur	20	3 S.	9 W.	Ward-Johnston 1	Coyote Hills
Car-Fad Oil Co.	2	6 S.	11 W.	Doran 1	Huntington Beach
D. D. Dunlap	2	6 S.	11 W.	Huntington Beach 2	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued					
Dunlap Trust	2	6 S.	11 W.	1	Huntington Beach
Hammil Oil Corp.	10	6 S.	11 W.	Lewis 2A	Huntington Beach
Herbert S. Kohlbush	34	5 S.	11 W.	Kohlbush 1	Huntington Beach
M. K. F. Oil Co.	11	6 S.	11 W.	1	Huntington Beach
Orco Oil Co.	10	6 S.	11 W.	H. B. 1	Huntington Beach
Pan Coast Oil Co.	2	6 S.	11 W.	Pan Coast 1	Huntington Beach
The Petroleum Co.	2	6 S.	11 W.	Wilson 4	Huntington Beach
Re-Mine Oil Co.	34	5 S.	11 W.	Humble 1	Huntington Beach
South Basin Oil Co.	2	6 S.	11 W.	93	Huntington Beach
Union Oil Co.	34	5 S.	11 W.	Brooks 9	Huntington Beach
Vicaroo Oil Co., Ltd.	10	6 S.	11 W.	S. & G. 1-A	Huntington Beach
Bachmann Petroleum Corp.	29	3 S.	9 W.	Kelly 1	Richfield
Standard Oil Co.	32	3 S.	9 W.	Kraemer 2 24	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 39	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 40	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 41	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 42	Richfield
SAN JOAQUIN COUNTY:					
Standard Oil Co.	19	2 N.	5 E.	McDonald Island Farms 2	----------
Standard Oil Co.	31	2 N.	5 E.	Tilden Comm. 1	----------
SAN LUIS OBISPO COUNTY:					
Aviation Oil Co.	15	11 N.	35 W.	Brintnall 1	----------
Barnsdall Oil Co.	1	32 S.	20 E.	Barnsdall-Foster KCL 1	----------
A. T. Jergins Trust	26	31 S.	12 E.	Indian Knob 1	----------
SANTA BARBARA COUNTY:					
General Petroleum Corp.	32	5 N.	30 W.	Erburu 20	Capitan
General Petroleum Corp.	32	5 N.	30 W.	Erburu 21	Capitan
Shell Oil Co.	32	5 N.	30 W.	Covarrubias 1 19	Capitan
Valley Oil Co.	20	9 N.	34 W.	Chief 1	Casmalia
Barnsdall Oil Co.	9	8 N.	32 W.	Tognazzini 2	Cat Canyon
O. C. Field Gasoline Corp.	4	8 N.	32 W.	Continental 1	Cat Canyon
The Petrol Corp.	9	8 N.	32 W.	Tognazzini 1-A	Cat Canyon
Todos Santos Oil Co.	4	8 N.	32 W.	McLoney 1	Cat Canyon
Signal Oil and Gas Co.	16	4 N.	29 W.	Appleford 98 9	Elwood
W. D. Shaffer, Trustee	9	9 N.	33 W.	Houk 1	Santa Maria
R. R. Bush Oil Co.	30	10 N.	33 W.	Hancock-Bush, California Lands 1	Santa Maria Valley
Echo Oil Co.	23	10 N.	34 W.	Echo 1	Santa Maria Valley
A. N. Macrate	23	10 N.	34 W.	Rice 1	Santa Maria Valley
A. N. Macrate	26	10 N.	34 W.	Fernandez 1	Santa Maria Valley
Union Oil Co.	24	10 N.	34 W.	Adam 2	Santa Maria Valley
Union Oil Co.	24	10 N.	34 W.	Mahoney 2	Santa Maria Valley
Union Oil Co.	24	10 N.	34 W.	Moretti 2	Santa Maria Valley
Union Oil Co.	25	10 N.	34 W.	Vincent 1	Santa Maria Valley
Claude Fisher	28	11 N.	28 W.	Cuyama 1	----------
101 Oil Co.	35	5 N.	33 W.	Hollister 1	----------
Tide Water Associated Oil Co.	2	4 N.	30 W.	Edwards Estate 1	----------
SOLANO COUNTY:					
Amerada Petroleum Corp.	23	4 N.	2 E.	Serpa 1	----------
Amerada Petroleum Corp.	26	4 N.	2 E.	M. Hamilton 1	----------
SONOMA COUNTY:					
Antonio J. Cardozo	34	5 N.	8 W.	1	----------
SUTTER COUNTY:					
The Buttes Oilfields, Inc.	2	15 N.	1 E.	4	----------
TULARE COUNTY:					
John W. Alford	28	16 S.	23 E.	Williams 1	----------
E. P. Jennings	4	24 S.	23 E.	1	----------
Seaboard Oil Corp.	16	23 S.	26 E.	Security 1	----------
VENTURA COUNTY:					
Petroleum Securities Co.	3	3 N.	19 W.	Home Ranch 4	Bardsdale
St. Louis Oil Co.	12	4 N.	23 W.	Pirie 3	Ojai
Bolsa Chica Oil Corp.	5	4 N.	18 W.	Hidden 1	Piru
Pacific Western Oil Corp.	4	4 N.	18 W.	Temescal 7	Piru
Tide Water Associated Oil Co.	6	3 N.	18 W.	Wiley Canyon 1	Piru
C. C. M. O. Co.	23	3 N.	24 W.	Oak Grove 2	Rincon
Continental Oil Co.	24	3 N.	24 W.	Grubb 6	Rincon
General Petroleum Corp.	7	3 N.	24 W.	Ferguson 5	Rincon
Colima Oil Co.	29	5 N.	19 W.	2	Sespe
Continental Oil Co.	7	3 N.	23 W.	Casitas 1	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

Glory Hole, now site of new incline shaft, and reduction plant at Klau Quicksilver Mine, San Luis Obispo County.
Photo by Herbert A. Franke.

PROSPECTING FOR LODE GOLD[1]

By E. D. Gardner[2]

PROSPECTING

A majority of the metal mines in the United States have been discovered by qualified prospectors who were searching for valuable minerals at the time. Chance, however. always has played a large part in finding mineral deposits. Some of the discoveries of the past were made by men on other errands, such as rounding up burros or hunting game. Accidental discoveries of ore bodies have been made in building roads and trails and in excavating for mine structures. Evidence of ore has been brought to the surface by burrowing animals and by ants; gold found in the craws of fowl has led to discoveries of deposits. Important discoveries have been made by men who had no knowledge of rocks or minerals; on the other hand, many ore bodies have been found by experienced prospectors, sometimes after hundreds of untrained men had already passed over the ground.

The prospector who carries on his work diligently and intelligently is of course more likely to be rewarded for his efforts than the lazy or unintelligent worker; nevertheless, it is obvious that if valuable deposits do not exist at the place being prospected none will be found. Conscientious and painstaking efforts to trace gold to its source usually disclose nothing more valuable than some narrow, unworkable seams; however, many deposits that were developed into profitable mines were found by this method of prospecting. Although some prospectors have made several lucky strikes, many others have spent their working lives searching for mineral without finding anything worth while. Probably only one prospector out of several thousand ever finds anything worth developing. Moreover, only 1 out of every 300 or 400 properties developed becomes a profitable mine.

Prospecting began in the Western States in the fifties as the miners looked for the source of gold found in placers. The search for gold has been continuous since that time; the number of prospectors in the field at any one time, however, has varied greatly. Except in some desert regions, practically all of the placer fields now being worked were discovered by oldtimers; most of the important gold districts also were found by early prospectors. Important discoveries of lode mines, however, have been made from time to time. Most of the area in the mining regions of the West has been gone over many times by prospectors, and nearly all of the easily found deposits have been located, but it is reasonable to expect that new gold mines will continue to be found. Most of the future discoveries undoubtedly will be of deposits that do not outcrop. Prospecting for such deposits requires considerable digging.

[1] "Extracted and reprinted from U. S. Bureau of Mines Information Circular 6843." Prospecting for Lode Gold and Locating Claims on the Public Domain.

[2] Supervising engineer, Southwest Experiment Station, U. S. Bureau of Mines, Tucson, Ariz.

Several important discoveries were made in 1934. One of these, the Rogers-Gentry gold mine at the edge of Antelope Valley in Los Angeles County, California, was found by an experienced prospector on an old patented homestead a number of miles from the nearest producing mine. The initial discovery at this mine was an iron-stained, decomposed, silicious limestone outcrop, with no vein structure evident at the surface, near a small, barren quartz outcrop and a water seep. Another discovery, the Silver Queen gold mine, in the same general region and near Mojave, California, was found by an experienced miner on an open fraction 400 by 1,400 feet in size between two old properties which were thought to have been worked out years ago. The Silver Queen discovery was made as the result of finding a single piece of float unlike any ore in the region. The vein did not outcrop; the discovery point was under 6 feet of cover.

To prospect for lode gold one should know first of all how to take care of himself in the hills or on the desert. He should be physically able to stand hard work and know how to use a pick and shovel. Most prospectors also have occasion to drill holes by hand and know how to use explosives. To prospect for lode gold intelligently one should be able to identify gold and the minerals usually associated with it, besides being able to distinguish one general class of rock from another.

Most prospectors work alone and are accustomed to solitude. As discoveries that can be sold for cash are few and far between prospectors must have some other resources for subsistence. Many prospectors work in the mines in the winter and prospect in the summer. Others do the assessment on claims for owners to earn enough money to buy supplies for prospecting. In the old days many prospectors were grubstaked by merchants, individuals, groups or individuals, or companies, usually on a 50-50 basis. The practice now is followed less than formerly, but a professional prospector of good repute usually can get a backer.

Favorable Areas

Although the old saying that "Gold is where you find it" is quite true, the probability of finding gold in paying quantities will be increased greatly if prospecting is done in areas geologically favorable for the occurrence of gold. Regions in which gold is known to occur naturally are more favorable for prospecting than those where no gold has ever been produced.

The important known gold deposits in the United States occur in regions where intense igneous activity has occurred at some time. The most promising fields for finding new deposits of gold, therefore, should be in or near igneous rocks.[3] Not all igneous formations, however, are favorable for the deposition of gold. It probably would be a waste of time to prospect in dark lava flows. Large masses of granites or related coarsely grained crystalline igneous rocks are unlikely to contain gold deposits unless cut by dikes or other intrusions of finer-grained and usually light-colored igneous rocks, such as porphyry, rhyolite, or andesite.

[3] According to Dana's Manual of Mineralogy, 14th ed., issued in 1929, p. 345, "Igneous rocks, as the name indicates, are those which have been formed by the cooling and consequent solidification of a once hot and fluid mass of rock material."

Areas are favorable for prospecting where the principal rocks are granites (as suggested above), schists, slates, greenstones, or related rocks cut by later intrusives. Areas in which the principal rocks are the light-colored, finer-grained igneous rocks, especially if of several varieties, are also favorable.

One of the most favorable areas for the occurrence of gold is where the country rock is made up of surface flows, sills, dikes, and other intrusions of these light-colored igneous rocks.

Profitable gold deposits sometimes are found around the borders of great masses of granitic rocks, both in the granites and in the surrounding rocks but more often in the latter.

Large areas of sedimentary rocks[4], such as shale, sandstone, and limestone, are unfavorable for prospecting unless the sediments are cut by the light-colored intrusions previously mentioned, and even where so cut the sedimentary areas seldom contain workable quantities of gold unless they have been metamorphosed (changed by pressure and heat) to slate, quartzite or marble.

Gold Lodes and Ore Shoots

Gold in paying quantities does not exist indiscriminately in country rock but where it has been deposited in definite zones usually termed "lodes." Solutions containing the gold have arisen from great depths and have been deposited by relief of pressure, cooling of the solutions, or other causes. For a lode deposit to have been formed there must therefore be some form of opening or zone of weakness through the rocks along which the solutions may rise. Earth movement or faulting commonly causes zones of weakness. Therefore, in prospecting it is well to keep a look-out for fracturing.

Parts of the lodes that contain gold in sufficient quantity to be ore (that is, material that can be mined at a profit) are called "ore shoots." Shoots seldom extend between walls but may be confined to a relatively narrow streak or streaks. Gold-ore shoots usually are relatively small. After a gold-bearing lode is located considerable work may be necessary to find an ore shoot; frequently the gold will not occur in sufficient quantity for any part of the lode to be worked at profit.

The simplest and most common form of gold lode is what is termed a "true fissure vein" by the miners. Fracturing, with or without faulting, has occurred in a relatively narrow zone with well-defined walls. The ore minerals have been deposited in this zone and may fill the space between walls completely. Usually, however, fractured country rock and, if the movement has been great, gangue or slickensides occupy part of the space.

Another type of lode is the shear zone. Here the walls usually are not well-defined. The ore-bearing solutions have deposited the gold and associated minerals in the cracks made by the fracturing. If present, ore shoots may occur anywhere in the fractured zone. Usually they overlap and occasionally may be parallel.

The contact between two different kinds of rocks, especially an igneous rock and something else as schist, is generally a line of weak-

[4] According to Dana, p. 350, "Sedimentary rocks are secondary in their origin, the materials of which they are composed having been derived from the decay and disintegration of some previously existing rock mass."

ness. Ore-bearing solutions may have been able to rise along the places of weakness and form ore bodies. Such a lode is called a contact vein. Gold ore also may occur in bedded sedimentaries where a fissure cuts a contact, particularly between limestone and quartzite, where conditions are otherwise favorable geologically for the deposition of ore.

Searching for Gold Deposits

In looking for gold deposits vein or lode outcrops are sought and when found are examined for gold-bearing material. Portions of the veins have been eroded away; on steep hills part of the outcrops may have broken off and rolled down the hillside. Mineral-bearing fragments of vein material are called "float." Many deposits have been found by tracing float to its source. In prospecting, a lookout always is kept for such material. Float in the gravel of large streams may have come from many miles distant. In such instances the presence of the float indicates only that the gold-bearing material exists in the watershed above. Where float is found on a hillside the fragments are sought upward until no more are found. If the surface is covered with overburden, trenching will be necessary to disclose the lead.

Lodes also may be located by panning loose material below for free gold. Placers are formed from disintegration of rock containing gold. During the ages gold lodes are eroded away at the surface, the gold-bearing rock is ground to powder, and the gold is concentrated in stream beds or desert deposits. The gold of rich placers, however, may have come from a multitude of narrow or low-grade streaks that could not be worked at a profit. The presence of placer gold in a stream bed indicates that the region above contains or has contained lode gold. In seeking for lodes in such a region the gravel of stream beds or debris of dry washes is panned to trace the gold to its source. If the gold suddenly plays out in the main watercourse attention then is directed to the side gulches, which in turn are followed up until no more placer gold is found. The debris on the mountainsides is then panned and the gold traced to its source. At this stage of prospecting float in the over-burden may help in the search or be the key to the source of the gold.

Occasionally rich accumulations, called pockets, of free gold are found in the hillside debris. Especially in California pocket hunters have made a living by searching out these accumulations. The same procedure is followed whether the search is for a lode or a pocket. Valuable deposits in place have been found by pocket hunters.

As placer gold travels from its source it becomes flattened or rounded. Angular or jagged gold usually has not traveled far. The same is true of float. Well-rounded fragments of vein quartz may have traveled far, while angular pieces are not likely to have been transported a great distance. In flat, glaciated country float or free gold may have come from hundreds of miles away and may signify nothing as far as the immediate region is concerned.

Quartz, which usually is a constituent of gold ores, is hard and resistant to weathering. Furthermore, frequently the mineralization of a vein is accompanied by silicification of the vein filling and the immediate wall rock, which increases the resistance to weathering and erosion. Hence, a majority of veins containing gold ores outcrop above the

surrounding surface. In flat regions, however, the outcrops may be covered with overburden brought down by floods. In some instances the vein may be badly fractured; any quartz present may be in narrow seams in a gangue of shattered country rock. When this is the case the vein at the surface may be softer than the adjoining wall rock and cause a depression. Trenching, therefore, is necessary to disclose the lode in place.

In searching for a hidden vein the following features which may be caused by the existence of a lode should be noted[5]:

1. A natural trench or ditch that does not run directly down the slope of the hill or mountain.
2. A sudden change of slope.
3. A sharp notch that crosses a ridge that has a rather uniform altitude on both sides of the notch.
4. Several springs in a line.
5. A sudden change in the kind or quantity of vegetation (may indicate a contact or, if the change in vegetation is found over a narrow strip of ground, a lode may be beneath).

Although many other possible causes may be responsible for these structural features some trenching would be justified if float was found immediately below and not above any particular one of them.

Iron sulphides, which frequently are associated with gold, oxidize to red or yellow oxides when exposed to the surface elements. The presence of a lode very often is disclosed by the stain of these iron minerals.

Present-day prospectors examine old cuts or other workings on abandoned claims. It is possible that with the increased price of gold and the improvements in metallurgy since the original work was done material passed up by the oldtimers may now be valuable.

With a few notable exceptions, the gold in lode deposits occurs as the native metal. At Cripple Creek and some of the other Colorado districts the gold is a constituent of telluride minerals; in general appearance these minerals resemble the iron sulphide minerals.

Gold and Associated Minerals

Gold can be identified readily by sight. It is the only soft, yellow substance with a metallic luster occurring in nature. It can be flattened easily without breaking and be cut or scratched readily with a knife. It is sometimes confused with pyrite, chalcopyrite, or other sulphide or with plates of yellow mica. Pyrite is too hard to be scratched with a knife, and sulphides that resemble gold crush into black powder. Yellow mica yields a white powder when scratched with the point of a knife. When any doubt exists the suspected substance ordinarily is not gold.

The principal gangue mineral in gold deposits usually is quartz. This mineral is distributed widely in mineralized areas, but a very small percentage of it will be found to contain gold. Glassy or what is called "bull quartz" by the miners seldom if ever is gold-bearing. Massive quartz leads may be very persistent but generally are barren,

[5] Butler, G. M. Some Hints on Prospecting for Gold; Arizona Lode Mines and Gold Mining: Bull. Univ. of Arizona, Tucson, Ariz., vol. 6, p. 251.

except in some cases where secondary quartz with more of a porcelain appearance has been deposited. In the Mother Lode region of California the gold usually is associated with this secondary quartz.

With a few exceptions gold below the zone of oxidization generally is associated with or accompanied by sulphides. The principal sulphide ordinarily is pyrite; in some cases, however, chalcopyrite, arsenopyrite, or galena may be the important gold carrier. Gold may occur, however, in quartz without the associated sulphides or their oxidization products or in veins where quartz is not important. For example, in the Oatman (Ariz.) district all the gold is free, and the principal gangue mined is calcite.

Iron streaks or vugs (cavities, usually lined with a crystalline incrustation) in quartz-lead matter are promising places for native gold to occur. Frequently if present it can be seen by the naked eye or with a glass, therefore the prospector is on the look-out for iron-stained or honeycombed quartz. Outcrops, consisting mainly of iron oxides or lead matter heavily impregnated with iron (called gossan), when found in a mineralized region should be tested for gold; the gossan may be at the top of copper or lead ore bodies with the latter two metals leached out. Sometimes the gossan carriers paying amounts of gold.

Any outcrop or float of iron-stained, fractured, light-colored igneous rock recemented with silica or showing evidence of silicification and banding should be investigated. The ore of the Silver Queen mine near Mojave, California, is of this latter type.

In glaciated regions and occasionally elsewhere sulphides occur at the surface. Moreover, float containing sulphides occasionally is found. Both outcrops and float usually are tested for gold by the prospector. Frequently the outcrop of a lead[6] is shown by green or blue copper stain. Should the original copper sulphide have been associated with gold the possibility of a deposit of gold ore exists.

Prospectors usually do not confine efforts to the search for gold but will locate any deposit that promises to be of value, irrespective of the kind of contained mineral. To be present in sufficient quantities for the material to have value as an ore the base metals must occur in amounts readily discernible by the eye; the base metals, however, may have been removed from outcrops by leaching.

Sampling and Panning

As mentioned before, gold occasionally is visible in vugs or high-grade seams, but usually the gold in its ores is not visible either to the naked eye or with a glass. Rock suspected of containing gold may be tested by assaying or panning. Of course, the former method is to be preferred, but the cost ($1 to $1.50 per determination) precludes its general use by most prospectors. Some of the large mining and smelting companies, however, will assay free a reasonable number of samples sent in by bona-fide prospectors. In this way they may be the first to learn of new discoveries.

[6] Commonly used as a synonym for ledge or lode. Many mining-location notices describe the locator's claim as extending a certain number of feet along and so many feet on each side of the "lode, lead, vein, or ledge." The word is pronounced "leed" and should not be confused with the metal lead.

Gold prospectors make a practice of panning (or horning) likely looking rock. The sample is first ground into powder. A small frying pan from the 10-cent store appears to be preferred by most prospectors for panning rock samples. Although the greater reliability of relatively large samples is realized most prospectors when grinding the rock by hand and panning in the field use 1- or 2-ounce samples. In prospecting, the best-looking material is panned. After the rock has been shown to contain gold the value per ton should be ascertained by assaying. Samples for assaying should be cut over a definite width of the exposed vein.

A competent panner can estimate fairly closely the gold content of ore with which he is familiar. An expert panner with a 1-ounce sample can detect gold in rock that will assay only about 0.02 ounce free gold per ton. A milligram of gold in an assay ton (29.168 grams) indicates 1 ounce of gold per ton of 2,000 pounds. An ounce adverdupois is 28.350 grams.

Not all gold-bearing rock pans. Where the gold is associated with or contained in sulphides, grinding in a mortar may not liberate enough of the gold to be detected in the pan. In the United States, however, the gold in outcrops usually has been liberated by oxidization to such an extent that it can be panned.

In searching for gold most professional prospectors carry a mortar and a canteen of water. Likely looking rock is panned as found. By this procedure a load of rock is not accumulated, and many samples are tested that would not be carried to camp. Furthermore, there is no confusion regarding the location of the gold-bearing material, as often is the case when samples are accumulated.

Although an experienced man may identify gold telluride in the ore or in the pan the sample should be assayed when their presence is suspected. Assays also are of course necessary to tell whether sulphides contain gold.

All major exposures of veins or other structures that appear favorable for the occurrence of gold should be sampled and assayed. No ore should be shipped without being assayed; almost invariably when this is done the shipper is disappointed. As mentioned above, samples should be cut across definite widths of the vein. Hand and grab samples of ore to be shipped are almost always high.

Surface Weathering

Weathering and leaching by surface solutions may remove the base metals from surface outcrops. Gold, however, is very resistant to leaching, and the weathering of the iron and associated minerals may increase the value per ton of surface ore; hence, it can not be expected that the value of the gold deposits will increase with depth; usually the contrary is true.

Prospecting on Patented Ground

Prospectors are reluctant to prospect on patented ground, as anything found would belong to the owners of the land. The author believes, however, that opportunites occur for finding new deposits on some of the thousands of idle patented mining claims held throughout

the West. Many of these claims are held by estates. Even where the owners of idle claims would be willing to draw up papers to the effect that a discoverer of new ore would benefit from his findings, the average prospector would decline to go to this trouble and conduct his searches elsewhere.

Prospecting Outfits and Provisions

The outfit to be taken on a prospecting trip depends upon the mode of transportation, the work contemplated, and the funds available. Enough equipment should be taken, but unnecessary articles make extra work. When a more or less permanent camp is established added equipment for personal comfort and efficiency can be obtained. Usually a cabin is built for a permanent camp.[7]

Transportation

An automobile is to be preferred for transportation if the region is one where it can be used. It has the advantage that a complete outfit can be carried and trips can be made out for supplies with relative ease. Most present-day prospectors use automobiles, especially in the desert regions. In mountainous regions away from roads the old stand-by, the burro, still finds favor. A prospector working alone generally uses two burros; occasionally, however, one animal suffices. A string of six or more burros will be used by a party; in this case a packer will be needed to look after the stock. About 150 pounds can be packed on each animal. A burro can live off the country and can go almost any place a man can get afoot. The principal objection to the use of burros is that they must be rounded up each day to keep them from wandering off beyond reach; a prospector will spend about a fourth of his working time chasing his burros. Mules or horses are used under some conditions but on the whole are less satisfactory for prospecting than burros. A horse cannot live off the country, and both mules and horses must be hobbled to keep them within reach.

Some prospectors prefer to get as near as possible to the area they wish to prospect by car and then carry supplies in on their backs to "spike" camps rather than bother with animals. Each year as more roads are built new country becomes accessible by car.

Camp Outfits

A roll of 3 or 4 blankets (the number depending upon the climate) in a canvas cover, a tent, a tight wooden box with a lid for storing food away from insects and rodents, and a canvas "war bag" for clothes usually make up the minimum camp outfit. A stove will be needed if prospecting is done in cold weather. A folding cot is desirable; in a permanent camp a bunk usually is built, as well as other needed furniture.

Tools

A full-sized ax and a good pocketknife are the first requirements for camping. A saw and hammer with 2 or 3 pounds of assorted nails

[7] Gardner, E. D., and Johnston, C. H. Placer Mining in the Western United States: Part I—Prospecting Outfits and Provisions; Inf. Circ. 6786, Bureau of Mines, 1934, 73 pp.

will be needed for fixing up a camp. A 50-foot length of ½-inch manila rope usually comes in handy. A miner's acetylene lamp provides a good light; a 5-pound can of carbide will last a camp all summer. A flashlight and a supply of batteries are conveniences that may be well worth their cost. A 2-quart canteen with a shoulder strap usually is needed for carrying drinking water or water for panning. A 2-gallon canteen and a 5- or 10-gallon water keg are necessary in some districts.

A pick, a long-handled, round-pointed shovel, a gold pan, and a prospector's pick are indispensable. If claims are to be staked a compass will be needed for running out the lines. A hand magnifying glass is a great help in identifying minerals. A mortar and pestle, a horn spoon, or a small pan will be needed for testing rock for free gold or other heavy minerals. A blowpipe outfit and determinative tables are of service to those who know how to use them. Bags for taking out samples usually are needed. Double paper bags with rubber rings cut from old automobile tubes for closing them permit large numbers of samples to be collected with little expense for bags.

A single-jack hammer with 2 or 3 moils will come in handy for taking samples and for loosening rock found in making cuts.

Some prospectors carry 1 or 2 sets of hand steel and several pounds of powder. A few rounds may be drilled and blasted before the steel has to be resharpened. If any extensive rockwork is to be done a forge and a set of blacksmith tools are necessary; usually these are brought in later.

Cooking Equipment

For a 1- or 2-man party a frying pan, a coffee pot, a large and a small stew pan or pot, and a Dutch oven are needed. A knife, fork, spoon, cup, and plate are required for each man. A few extra plates come in handy. A good butcher knife, a water pail, a can opener, and a few tea towels complete the outfit. Other dishes can be taken according to personal preferences.

Provisions

The variety of food taken on prospecting trips depends upon the method of transportation and the prospector's pocketbook. If the supplies are to be packed on animals bulky foods, such as potatoes and canned articles, are omitted. If there is need for economy in making purchases the list will consist mostly of dried staples and vegetables, if available locally.

Bacon, flour, beans, oatmeal, dried or canned fruit, coffee, syrup for hot cakes, and sugar and canned milk for the coffee are the standbys in prospectors' camps. As funds get low more beans and less bacon are eaten, and canned fruit is omitted. Canned tomatoes are in common use; they are cheap and supply needed food elements not contained in dry staples (for example, they help to prevent scurvy). Where available locally Irish potatoes, onions, and other vegetables are eaten. Fresh meat is not used much in camps in summer on account of the difficulty of keeping it.

A proper balance should be made in compiling a "grub" list so that needed items will not run short. Everyone prefers certain articles

of food, and these likes should be followed as much as practicable. It has been found by experience, however, that fancy groceries are the ones left over, and the first supplies to be used are bacon, potatoes and flour. Plain, wholesome fare seems to be preferred in camp, especially where hard work is done.

The following weekly allowance of food for one person to give a balanced diet is condensed from suggestions made by Doctor Smith:[8] Three 1-pound cans evaporated milk; 2 pounds potatoes; 4 pounds onions, cabbage, beets, or other vegetables; 3 pounds citrus fruits, 6 pounds fresh apples, or equivalent dried prunes, apricots, etc.; 3 pounds dried beans; 6 to 8 pounds cereals, wholewheat flour or bread, rolled oats, shredded wheat, etc.; 2½ pounds dried meat, bacon, ham or cheese (fresh meat or eggs may be substituted if available); 3 pounds sugar; 1 pound coffee; ¼ pound salt; ½ pound butter; and baking powder.

The cost of provisions for prospecting in the West will average about 50 cents per day per man. Many prospectors live in the hills when short of funds on as little as 25 cents per day each; they are not well-nourished, however, and do not have a balanced diet.

In many districts of the Southwest water must be carried. The quantity required depends upon the time of year and the amount of work done by the miner. Men working where temperatures range from 100 to 110° drink 2 gallons or more of water per day; under such conditions a 10-gallon tank would last one man 3 days, allowing for cooking but not for the radiator of a car. In cooler weather a 10-gallon tank should last one man a week or 10 days.

Clothing

The most important item of clothing is a pair of stout, thick-soled shoes of good quality, preferably hobnailed. If an extensive trip is planned a second pair may be needed. Other clothing can be patched, but when a prospector's shoes go to pieces his trip is ended. A pair of rubber boots will prove a comfort if much placering is done.

Woolen socks to wear under the heavy shoes help to prevent blisters; several pairs may be worn out in a season.

Other clothes are chosen for the climate and service. A leather jacket is very serviceable and comfortable in cool weather, or a sheepskin coat may be needed when it gets colder. Many prospectors in mountainous regions wear flannel shirts and woolen underwear. Overalls are a common garb.

A complete change of clothing should be taken on all but the shortest trips to permit changing into dry clothing after being caught out in the rain or working in water all day.

First-Aid Supplies

As prospectors are likely to be away from medical aid, some medical and first-aid supplies should be taken along. These should consist of a laxative (castor oil or salts), iodine or mercurochrome to disinfect cuts or bruises, and a first-aid kit. A snake-bite kit may also prove invaluable.

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[8] Smith, Margaret Cammack, Food Suggestions for Prospectors; Arizona Gold Placers and Placering: Bull. Univ. of Arizona, Vol. 3, no. 1, Jan. 1, 1932, pp. 96-98.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

John Charles O'Brien has been appointed junior mining engineer and assigned to the duties of librarian in the San Francisco headquarters of this Division, filling the vacancy created by the resignation of Herbert A. Franke. Mr. O'Brien is a graduate of the University of Minnesota, 1912, and has had a variety of experience in mining operations in Montana, Idaho, and California. He was at one period employed on a temporary assignment with the Division of Mines for several months in 1931-1932.

January 8, 1937, marked the completion of 25 years of service of the present state mineralogist on the staff of the Division of Mines and its predecessor the State Mining Bureau. He began his duties as librarian on Jan. 8, 1912, under Wm. H. Storms and continued under the succeeding state mineralogists, Fletcher Hamilton and Lloyd Root, advancing through the positions of field assistant, statistician and curator, and deputy state mineralogist to appointment as state mineralogist, August 1, 1928, during the administration of Governor C. C. Young.

The occasion was suitably remembered in a presentation by the staff of the division of a bouquet of beautiful red roses and a polished onyx desk-pen set.

New Publications.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, July, 1936, being Chapter 3 of State Mineralogist's Report XXXII. This chapter contains: 'Mines and Mineral Resources of Calaveras County'; and the following Special Articles: 'Placer Mining in California by Power Shovel'; 'Assessment Work on Mining Claims Within Withdrawn Areas'; 'Joshua Tree National Monument'; 'Cost of Producing Quicksilver at a California Mine in 1931-1932'; 'The Age of Mineral Utilization.'

Commercial Mineral Notes' (Nos. 163-165 inc.), November, December, 1936, and January, 1937, respectively. These 'Notes' contain the lists of 'mineral deposits wanted, and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology,' and to others on payment of 15 cents postage paid in advance for the year. As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to two and three pages in recent months.

Mails and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products, and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

CALIFORNIA'S MINERAL PRODUCTION IN 1936 SHOWS MARKED INCREASE

The total value of the mineral production of California for the year 1936, just closed, is conservatively estimated by the Statistical Division as $300,557,000. This is in part detailed in the tabulation below, but as there are more than 50 mineral substances on California's commercial list, figures on the most important items only are available at this early date. The blank report forms are being mailed to the operators in all mineral lines, and the detailed and complete report will be compiled and published later.

The estimated total of $300,557,000 is an increase of approximately $37,716,000 over the 1935 production total value, and is the largest since 1929. The principal increases in value of output over those of the previous year were shown by petroleum, cement, gold, miscellaneous stone, brick and hollow building tile, silver, lead, copper, and miscellaneous industrial materials. The only important mineral substances to show decreased values were natural gas and zinc.

The value and amount of the petroleum output showed increases over those of 1935, with a total quantity of about 214,212,000 bbls., an increase of about 3.5% over that of 1935. The average price of all grades of crude oil was higher than that of the previous year. There was an increase for the lighter gravity oils the latter part of February and other minor changes throughout the year.

Receipts of bullion at the mint and smelters showed an increased output of gold of some 159,000 fine ounces over 1935. All other major metals, with the exception of zinc, showed an increased output. The increased gold production and higher prices for these metals stimulated their yield and brought about the reopening also of the Walker Mine, Plumas County, for many years a large producer of copper.

Of the structural group practically all the materials under this heading showed increased outputs and values. This was accounted for by the fact that building permits in 51 principal cities of the State increased 80% over the previous year as well as a marked increase in large construction and public works. Both the miscellaneous industrial and saline products showed an increase in their totals.

The estimated values and quantities for 1936 are as follows:

$ 36,800,000	1,050,000 fine ozs.	gold.
1,561,000	2,027,000 fine ozs.	silver.
950,000	10,350,000 lbs.	copper.
68,000	1,490,000 lbs.	lead.
2,000	40,000 lbs.	zinc.
677,000	9,500 flasks	quicksilver.
310,000	other metals including	chromite, platinum, tungsten ore, etc.
200,639,000	214,212,000 bbls.	petroleum.
16,676,000	290,370,000 M cu. ft.	natural gas.
16,779,000	13,264,000 bbls.	cement.
7,950,000	crushed rock, sand and gravel.	
1,975,000	brick and hollow building tile.	
1,570,000	other structural materials, including bituminous rock, granite, magnesite, marble, standstone, slate, etc.	
4,775,000	miscellaneous industrial materials.	
9,825,000	salines, including borates, potash, iodine, salt, soda, etc.	
$300,557,000	total.	

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting materials from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20719 ELLSWORTHITE—Titanoniobate of U, Ca and Fe.
From Hybla, Ontario, Canada.
Donor: Wilfred C. Eyles. October, 1936.

20720 SCHEELITE CRYSTALS IN QUARTZ.
From Zinowald, Bohemia.
Donor: Wilfred C. Eyles. October, 1936.

20721 SCHEELITE Crystals ($CaWO_4$) Calcium Tungstate.
From Soeul, Korea.
Donor: Herbert Salinger. October, 1936.

20722 HUBNERITE ((Mn, Fe) WO_4) Manganese Tungstate.
From Los Gyas Mine, Puma County, Arizona.
Donor: Herbert Salinger. October, 1936.

20723 GOLD ORE, a product of secondary enrichment by the oxidation of sulphide minerals.
From the Recovery Mine, Chicago Mining District,
Mono County, California.
Donor: W. F. Murray and Walter Benge. October, 1936.

20724 THAUMASITE ($CaSiO_3.CaCO_3.CaSO_4.$ 15 H_2O).
From Paterson, New Jersey.
Donor: Wilfred C. Eyles. November, 1936.

20725 CHRYSOTILE ASBESTOS.
From Western Fresno County, California.
Donor: A. D. Davenport. November, 1936.

20726 FOSSIL OF SEA LILY OR CRINOID.
From Simmern, Hunsruck, Germany.
Donors: Otto Fuetterer and Peter Kuhn. November, 1936.

20727 FOSSIL OF SEA STAR.
From Simmern, Hunsruck, Germany.
Donors: Otto Fuetterer and Peter Kuhn. November, 1936.

20728 FOSSIL OF TRIBOLITE.
From Simmern, Hunsruck, Germany.
Donors: Otto Fuetterer and Peter Kuhn. November, 1936.

20729 SLATE (Gray).
From the Eureka Slate Quarry, Kelsey, El Dorado County, California.
Donor: John V. Roberts. November, 1936.

20730 SLATE (Black).
From the Eureka Slate Quarry, Kelsey, El Dorado County, California.
Donor: John V. Roberts. November, 1936.

20731 THENARDITE ($NaSO_4$) Sodium sulphate crystal group.
From Carisa Plains, San Luis Obispo County, California.
Donor: T. V. Little. November, 1936.

20732 THINOLITE—A tufa deposit of calcium carbonate.
From Northwestern Nevada.
Donor: L. C. Porter. November, 1936.

20733 'SALMON SPAR,' Calcite ($Ca\ CO_3$) Calcium Carbonate.
From near Baxter, on th U. P. Ry., San Bernardino County, California.
Donor: Elmo Proctor. December, 1936.

20734 SILVER-GOLD ORE.
From Dunn Claim (Formerly Silver King Mine)
Granite County, Montana.
Donor: A. G. Dingle. December, 1936.

20735 GOLD ORE.
From Cardiff Giant Mine, Gibbonsville, Idaho.
Donor: A. G. Dingle. December, 1936.

20736 SILVER (Crystallized).
From electrolytic refinery, Loreto Mill of Campañia Real del Monte y Pachuca, Pachuca, Mexico.
Donor: Walter W. Bradley. December, 1936.

20737 SILVER ORE—ARGENTITE (Ag_2S); and PYRITE (FeS_2). in quartz-cemented breccia, from Pachuca, Mexico. Also carries some gold.
Donor: Walter W. Bradley. December, 1936.

20738 "RIPPLE STONE" (Gypsum after Anhydrite).
From the Delaware formation, Guadalupe Mts., southwest of Carlsbad, New Mexico.
Donor: T. M. Cramer. December, 1936.

20739 POTASH "ORE" (40% SYLVITE, KCl; 58% HALITE, NaCl; 2% clay, Polyhalite, Langbanite, etc.).
From 1000 ft. level, stratum 11 ft. thick, U. S. Potash Company mine, 22 miles east of Carlsbad, New Mexioo.
Donor: T. M. Cramer. December, 1936.

20740 ARGENTIFEROUS ANTIMONY.
From Round Mountain, Nevada.
Donor: Jim Cullen. December, 1936.

20741 SOAPSTONE.
From Shingle Springs, El Dorado County, California.
Donor: Jim Bernett. December, 1936.

20742 TOURMALINE (Black) inclusions in Quaratz.
From Mt. Thompson, Plumas County, California.
Donor: J. L. Williams. December, 1936.

20743 GALENA (PbS) lead sulphide, with Calcite ($CaCO_3$) calcium carbonate. Crystals well formed.
From Montreal Mine, Century, Oklahoma.
Donor: L. B. Damron. December, 1936.

20744 SPHALERITE (ZnS) zinc sulphide. Well crystallized.
From Montreal Mine, Century, Oklahoma.
Donor: L. B. Damron. December, 1936.

20745 Model of Square-set Timber used in Comstock Lode.
Donor: Otto Fuetterer. November, 1936.

20746 CURTISITE, Highly fluorescent.
From the site of the U. S. Mint, San Francisco, California.
Donor: Wilfred C. Eyles. December, 1936.

20747 VOLCANIC BOMB.
Mostly Pumice with some Obsidian.
From Mono Craters, Mono County, California.
Donor: Walter W. Bradley. January, 1937.

20748 GOLD ORE.
From Lone Wolf Mine, three miles from Downieville, Sierra County, California. Assays $3,200 a ton.
Donor: R. F. Bibb. January, 1937.

20749 GOLD ORE—high grade.
From Gold Producer Mine, eight miles northwest of Redding, Shasta County, California.
Donor: R. F. Bibb. January, 1937.

20750 MANGANESE ORE (Pyrolusite), battery-grade or "chemical" ore.
From Phillipsburg, Montana.
Donor: Jack Devenish. January, 1937.

LABORATORY

FRANK SANBORN, Mineral Technologist

Prospecting for and development of California's mineral wealth appears to increase rather than decrease as the state grows in population. During the year, 1936, approximately 7000 samples were received and identified at this laboratory. Also, additional information and help was given to more than a hundred minors and prospectors who sought information on recovering gold and platinum from sluice box concentrates, on detecting tungsten in an ore, and many other problems.

The detection of the calcium tungstate, scheelite, by its fluorescense is very interesting and practical, and we have already given instructions and demonstrations on this method of prospecting to a number of miners. Anyone desiring information on the detection of scheelite by the ultra-violet ray may call at our laboratory where it will be given by a practical test.

Assistance in finding a market for minerals is given to those who make such a request. Those who desire to sell a mineral should submit a small sample of it to this department when help is wanted in finding buyers.

LIBRARY

J. C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it its also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National.

U. S. Geological Survey:

Topographic Sheets:

California:

Redrock Mountain, Quadrangle, Los Angeles Co.
Warm Spring Quadrangle, Los Angeles Co.

Professional Papers:

No. 182 The Tertiary Floras of Alaska.

Water Supply Papers:

No. 777 Water Levels and Artesian Pressure in Observation Wells in U. S., 1935.
791 Pacific Slope Basins in California, Part 11.
793 Snake River Basin, Part 13.

U. S. Bureau of Mines:

Economic Paper:

18. Analysis of the Progress in Mechanical Cleaning of Bituminous Coal from 1927-1934.

Books:

John Hays Hammond Library:

Metallurgical Practice, by Carle R. Hayward.
Treasures in the Earth, by Edward F. Fitzhugh, Jr.
The Story of the Gems, by Herbert R. Whitlock.
The Gold Mines of South Africa, by Owen Letcher (four books in one volume).
Soils, Their Origin, Constitution and Classification by G. W. Robinson, M.A.
Engineering Geology, by Cyril S. Fox.
Structural Geology, by Bohuslav Stoces and Chas. Henry White.

Books:

Cyanidation and Concentration of Gold and Silver Ores, by John Van Nostrand Dorr.
Handbook for the Amateur Lapidary by J. Harry Howard.
Carbon Dioxide, by Elton L. Quinn and Chas. L. Jones.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, National.

U. S. Geological Survey:

Bulletins, Water-Supply Papers, Annual Reports, Professional Papers, Circulars, Monographs, Topographic Maps, and Special Publications.

U. S. Bureau of Mines:

Bulletins, Technical Papers, Economic Papers, Reports of Investigations, Information Circulars and Miners' Circulars.

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon Bureau of Mines and Geology, Corvallis.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.

Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, Uinversity.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.

Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburg, Pennsylvania.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nickel Cast Iron News, New York City.
Northwest Science, Moscow, Idaho.
Northwest Mining, Spokane, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of California Journal of Mines and Geology, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of California Journal of Mines and Geology.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.70
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.70
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	1.25
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.60
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.00
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.55
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	$0.75
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.90
Mines and Mineral Resources of Plumas County, 188 pp., paper	.60
Mines and Mineral Resources of Sierra County, 144 pp., paper	.60
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.00
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.30
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.30
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.30
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.30
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.30
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.30
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.30
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.30
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.35
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.30
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.35
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.30
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.30
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.30
April, 1928, Mines and Mineral Resources of Mariposa County	.30
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.30

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	$0.30
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.35
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.35
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.35
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.35
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.30
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.35
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.35
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.35
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.35
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.30
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.35
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.35
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits. Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.65

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

Price Postpaid

Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:

January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties $0.90

July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543 ..... .90

Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits ..... .50

April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores ..... .90

October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas ..... .50

Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation ..... .50

April. A Geologic Section Across the Southern Penninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits ..... .50

July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights ..... .50

October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County ..... .50

Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Gold Mines of Placer County, including Drag-line Dredges. Geologic report on Borax Lake, California ..... .50

April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum .50

July. Mines and Mineral Resources of Calavaras County Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization	$0.50
October. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco Biennial Report of the State Mineralogist, Properties and Industrial Applications of Opaline Silica	.50
Subscription, $2.00 postpaid in advance (by calendar year, only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----
January, **February, **March, April, **May, **June, **July, August **September, **October, **November, **December, 1921	Free
January, February, March, April, May, June, **July, **August, September, **October, **November, December, 1922	Free
January, February, **March, **April, May, **June, **July, August, September, **October, November, **December, 1923	Free
January, February, March, April, May, June, **July, August, September, October, November, December, 1924	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1925	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1926	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1927	Free
January, February, March, April, **May, June, July, August, September, October, **November, **December, 1928	Free
January, February, March, April, May, June, July-August-September, October-November-December, 1929	Free
(Published quarterly beginning July, 1929)	
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free
January-February-March, April-May-June, July-August-September, 1931	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1932	Free
January, February, March, 1933	Free
April, May, June, 1933	Free
July, August, September, 1933	Free
October-November-December, 1933	Free
January-February-March, 1934	Free
April-May-June, 1934	Free
July-August-September, 1934	Free
October-November-December, 1934	Free
January-February-March, 1935	Free
April-May-June, 1935	Free

BULLETINS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	$0.10
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----
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Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

Vol. 33 APRIL, 1937 No. 2

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QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIII

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
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PACIFIC OCEAN
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MODOC
SHASTA
LASSEN
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LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
IMPERIAL
SAN DIEGO
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to California Journal of Mines and Geology, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

MINERAL RESOURCES OF PLUMAS COUNTY

Geography.

Plumas County is located in the northeastern portion of the state just to the south of Lassen County and north of Sierra County. The state of Nevada almost touches it on the east, but a jutting strip of Lassen County only a few miles wide intervenes. The shape of the county, as it appears on a map, is that of a camel at rest, head up, and facing the west. This peculiar shape results from following the divides between streams with the boundary lines. The entire county is drained by Feather River and its branches, and the boundaries are such that practically no drainage flows into any other stream than the Feather.

Northern California is a region of mountains that belong to three different ranges, the Coast Range, including the Klamath Mountains, the Cascade Range and the Sierra Nevada. Plumas county lies at the extreme northern end of the Sierra Nevada, but touches the volcanic Cascade Range to the north near Lassen Peak, and is bordered on the east by the Great Basin. Fifty miles to the west is the Great Valley of California (the Sacramento), to which flow the waters of the melting snows of the northern Sierra Nevada by way of the picturesque Feather River.

Quincy, the county seat, located in American Valley, is a town of 860 people. The total population of the county by the 1930 census was 7913. The area of the county is 2594 square miles or 1,660,000 acres, of which 865,000 acres of timber land are reserved by the United States government, and 251,000 acres of timberland are privately owned. Tillable land amounts to 120,900 acres. The average annual precipitation is 41.57 inches of water, which falls almost entirely as winter snow.

Topography.

The outstanding feature of Plumas County is its high relief; steep river canyons, which have been cut several thousand feet deep by swift streams, are the rule, and mountain peaks abound. The various forks of Feather River have cut the entire southern and western portions of the county into deep canyons with high ridges, and the result is a region of difficult accessibility. However, many fertile valleys lie in these forest-covered mountains; the largest is Indian Valley in the north-central portion, and others of importance are American, Genesee, Mohawk, and Sierra valleys. To the north, Lake Almanor, an artificial lake occupying what was formerly known as Big Meadows, is a prominent feature of the topography. To the south are many smaller mountain lakes. American, Indian and Genesee valleys are at elevations of 3500 to 3700 feet, while Sierra Valley is at 5000 feet. The ridges and peaks are generally at elevations of 6000 to nearly 8000

feet, while the North Fork Feather River Canyon to the west has been cut down to an elevation of only 1500 feet.[1]

This combination of mountains, forest, swift streams and mountain lakes makes a region very attractive to the fisherman, hunter and vacationist. The residents are encouraging these people to go into Plumas County; and many summer resorts, camps and summer homes are being built there.

Timber.

Forests of very fine timber cover practically the whole of Plumas County; and even though a large part of its area is forest reserve, extensive lumbering operations are being conducted on privately owned land. The largest mill is that of the Red River Lumber Company, at Westwood, just across the line in Lassen County. Much of the timber to supply this mill has been cut in Plumas County. Other large mills are in operation at Quincy and at various points along the Western Pacific Railroad, including a new one on the new line of this road at Greenville.

Transportation.

The main line of the Western Pacific Railroad runs practically through the center of the county, following the canyon of the North Fork of Feather River on a roadbed cut largely from the solid rock of the canyon walls, and crossing the Sierra Nevada at an easy grade, said not to exceed one per cent. This road requires no snowsheds, and for many years it has not even been necessary to plow snow from the tracks. Since our last report a new line has been run by this company from a point on the main line near Keddie through Greenville, and along the shore of Lake Almanor continuing north to connect with the Great Northern at Bieber. The Great Northern line runs to Klamath Falls, Oregon. The Indian Valley Railroad connects with the Western Pacific at Paxton and extends through Indian Valley to the copper mines at Engelmine, which mines are no longer in operation; but the railroad is still in use. Many railroads used for logging are located near Westwood and Chester, just to the north in Lassen County, and from Red Clover Valley to Loyalton in Sierra County.

Many places in the canyon on the North Fork of Feather River that are interesting from the standpoint of mining have been accessible only by riding on a train to one of the small stations in the canyon and finishing the trip on a mountain trail. This condition has now been corrected to a great extent by the new state highway which follows the canyon mostly on the opposite side from the railroad. It will probably be completed in 1937. Many points in the steep canyon and on the ridges will still be accessible only by pack train, but the new road affords good starting points for branch roads, which can be built to open up large areas of possible value for mineral deposits.

A hard-surfaced road from Red Bluff to Susanville crosses the northern part of Plumas County and a hard-surfaced branch extends southward to Quincy. From Quincy hard-surfaced roads run to Reno, Nevada, and to Oroville in Butte County. Roads with surfaces of

[1] U. S. Geol. Survey, Topographical Sheets: Downieville, Bidwell Bar, Sierraville. Honey Lake, Lassen Peak and Indian Valley Special.

gravel and crushed rock radiate to many other portions of the county. During the winter season many of them, including the one from Quincy to Oroville, via Bucks, are blocked by snow.

Power.

Many wonderful sites for the generation of hydro-electric power are afforded by the high relief and abundant water supply of Plumas County. Several of these have already been developed and are in use, but many remain for future development. The Caribou plant, built by the Great Western Power Company, but now owned by the Pacific Gas & Electric Company, shown in the accompanying photograph, is typical of the plants now in operation. It receives water from Lake

Caribou Power House.

Almanor through a tunnel and penstocks under a head of 1100 feet, and has a generating capacity of 88,000 horsepower. The Las Plumas plant, lower on the north Fork, and just across the line in Butte County, utilizes the outflow of the Caribou plant, together with such water as flows into the river between plants, and has a generating capacity of 87,000 horsepower.

The powerhouse most recently constructed is at Storrie on the North Fork. It draws water from a main storage reservoir of a capac-

ity of 116,000 acre-ft. at Bucks Meadow. The plant operates under a head of 2562 feet of water and develops 70,000 horsepower.

Geology.

The areal geology of most of Plumas County has been worked out by Diller[1] and Turner[2] and their maps have been used in compiling the geological data shown as an overprint on the accompanying map. While this gives a good idea of the general geology of the region, all mine operators will find that more detailed maps on a larger scale are necessary for a proper understanding of each particular mineral deposit. During the present survey, the fact was noted that many of the deposits occupy fissures that were first filled by igneous dikes of various kinds. These dikes are too small to show on the scale of the accompanying map, while a map of large enough scale to show the relations of each dike to the mineral deposit that occurs with it will prove of very great value in the development of that deposit.

By far the most detailed study of the geology was made by Diller in the Taylorsville region. Lindgren[3] has made a report on the gold-bearing Tertiary gravels. The works of Diller, Turner and Lindgren have been freely used in the following descriptions. However, mineral deposits of important economic value have been discovered since their work was done. These include the barite near Lake Almanor, the great copper deposit of Walker Mining Company, and the manganese at Crystal Lake. These are described below under the respective mineral names.

The Taylorsville region is of great interest geologically because in the uplift and folding of the Sierra Nevada, a fold was overturned in such a way as to preserve a series of Jurassic sediments from erosion. This is one of the few localities in the Sierra Nevada where Jurassic sediments have not been eroded away. Other formations representing an unusually complete geological column are present near Taylorsville also.

The following general description (with a few additions) is adapted from Lindgren:

The Paleozoic and early Mesozoic seas once extended over the site where the Sierra now lifts its broad back. The shore line followed roughly the eastern boundary of the State of Nevada, and most of California was beneath the sea receiving sedimentary deposits thousands of feet thick. Some oscillations of sea and land took place, and some folding, but the region that we now call Plumas County was beneath the sea most of the time from early Silurian to the close of the Jurassic. Toward the close of the Mesozoic era the sediments were compressed in heavy folds, and the intrusion of granitic magmas forced them upward to lofty summits; after the intrusion the fissures and joints of granitic rocks and altered sediments became filled with veins and seams of gold-bearing quartz. A long period of erosion in the early Cretaceous planed down the new-born mountains. The concentration of the gold from the veins began in countless streams.

[1] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Lassen Peak folio (No. 15), 1895; Geology of the Taylorsville Region, California, U. S. Geol. Survey Bull. 353, 1908.

[2] Turner, H. W., U. S. Geol. Survey Geol. Atlas, Bidwell Bar and Downieville folios (No. 43 & No. 39).

[3] Lindgren, Waldemar, The Tertiary Gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, 1911.

Pauses in the erosion, when the topography had beeen reduced to gentle outlines, permitted deep rock decay and promoted the liberation of gold from its matrix. Renewed uplift quickened erosion and facilitated the further concentration of gold. Throughout Cretaceous and Tertiary time these conditions continued. Fluctuations of the western shore line at times extended the streams far into areas now occupied by the Sacramento and San Joaquin valleys, or caused these water courses to debouch upon flood plains reaching high up on the flanks of the range. Faulting movements, with downthrow on the east side, probably in Cretaceous time, had transformed an approximately symmetrical range to a monoclinal one with steep easterly slope. Gradually the mountains were thus reduced to gentler slopes and the canyons widened to valleys. Meandering among longitudinal ridges, the rivers flowed from low divides to rolling foothills and the whole slope was clothed in the dense vegetation of a damp semitropical climate. At this time the region probably resembled the low coastal plane of Florida, with one river (Jura River) flowing north into an arm of the sea near the present site of Susanville. Other rivers flowed westerly and southwesterly.

Long quiescent volcanic forces asserted themselves toward the end of Tertiary time, contemporaneously with the greatest volcanic activity in the Great Basin. Rhyolite flows filled the valleys, covered the auriferous gravels, and outlined new stream courses in the old valleys. Renewed disturbance began along the scarcely healed eastern breaks, resulting in a westward tilting of the main blocks, probably combined with normal faulting. In consequence of this disturbance the monoclinal nature of the range became strongly emphasized and the streams immediately began to cut their beds deeper; they repeatedly crossed their old courses and the concentration of gold in the new canyons proceeded under less favorable torrential conditions. Eruptions of andesitic tuffs began in enormous volume and effectually buried a large number of the streams, filling their valleys to the rims. At the close of the Tertiary period a steaming, desolate expanse of volcanic mud covered almost the whole of the northern Sierra, in startling contrast to the peaceable verdure-clad hills of the Miocene. In a thousand rills the storm waters flowed down the slope, excavating rapidly in the soft tuffs. The rills became gullies, ravines, creeks, and new master streams. Torrential grades magnified the erosive power, and thus began the canyon cutting epoch of the late Pliocene and early Quaternary, amazing in its results, as we see them today. The new streams excavated sharp, V-shaped trenches in the hard rock to depths of 1000 to 4000 feet below the surface of the flows. In many places the old rivers of the Tertiary period were exposed and cross sections of their valleys are now seen on the steep canyon slopes high above the present river beds. Large stretches of the old channels remained secure below their blanket of 1000 feet of hardened volcanic mud. Wherever the canyon-cutting streams destroyed the old channels the gold in those channels became concentrated in the canyons and thousands of quartz veins added to the previous concentrates; but owing to the steep grades of the Quaternary rivers much of the detrital material and the fine gold was swept out into the valley at the western foot of the range over alternately advancing and retreating flood plains.

The barren lava flows and the canyon slopes again became clothed by vegetation, this time of a type belonging to a cooler but still temperate climate. Later in the Quaternary the scene changed again. The summits became covered with persistent snows, which eventually consolidated to névé and to ice. Glaciers filled the upper valleys, but only for a comparatively brief time, disappearing rapidly before the drying winds of a warmer climate and leaving the summit region a desolate expanse of dazzling white, bare granite or reddish schists.

During the last brief span of a few thousand years the Sierra Nevada has remained as we now see it with the pleasing oak groves of the foothills, the somber giant pines of the middle slopes, and the storm-scarred hemlocks of the summit ridges.

Structure

All sedimentary formations older than the Cretaceous have been raised and folded during an uplift of the Sierra Nevada so that they now exhibit steep dips. Tertiary gravels and lavas overlie them, and dip at gentle angles. The predominant dip of the older formations (pre-Cretaceous) particularly in the Taylorsville region is westerly. The overturned fold of Jurassic rocks in this region has been faulted, so all dips that can now be seen are westerly and parallel to the dips of Carboniferous and Silurian rocks which have not been overturned. The fact of the overturning has been established by identification of the fossils contained in the sediments. The older Jurassic beds now overlie the younger ones.

The overthrust fault that accompanies the overturned fold is one of the major faults in the region. Others are related to the great fault that forms the east face of the Sierra farther south. Still others are in line with the faults that bound the block in which Lake Tahoe is located.

SEDIMENTARY ROCKS

Silurian (S)

On the accompanying map, under the heading, Silurian marine meta-sediments, are included the Grizzly formation and the Montgomery limestone of Diller. The Grizzly formation is a gray, well-defined but thin-bedded quartzite overlain by lentils of limestone, and interstratified with shaly, often siliceous slate (argillite) having irregular cleavage. The beds of quartzite range from 5 ft. to 20 ft. in thickness and run out into shale in a short distance. The shale beds are thicker, greenish gray to drab, but sometimes black and flinty. The lighter colored shales are often sandy. This formation occurs on the northeast slope of Grizzly Mountains near Taylorsville in a belt six miles long, and with a stratigraphic thickness of 400 ft. Overlying the Grizzly formation, on the crest of Grizzly Mountains is the Montgomery limestone in lentils reaching a maximum length of 200 ft. and thickness of 60 ft. The limestone is light to dark bluish-gray, and cleaves into plates. Occasional knots or bunches of chert are found in it, and Silurian fossils have been identified.

Devonian (D)

The Taylorsville formation of Diller is mapped under the heading: Devonian marine meta-sediments. It is composed of fine sediments, chiefly slates and thin-bedded sandstones, with small layers of black chert and occasional irregular masses of red chert. Some conglomerate is found at the base, and some light-colored quartzite near the middle. The formation occurs in a belt 35 miles long from the Lassen Peak region to a point south of Taylorsville, and on to the fortieth parallel. The stratigraphic thickness measured south of Taylorsville is 1800 ft. Similar strata of Devonian age are found in the Redding quadrangle, Shasta County.

Carboniferous (C)

Carboniferous marine meta-sediments comprise the Calaveras group named by Becker, Lindgren and Turner in their survey of the Gold Belt, to include a great body of altered sandstones, shales, and limestones; also the Arlington, Peale, Shoo Fly, and Robinson formations of Diller. The Arlington formation is made up chiefly of fine, gray, thin-bedded sandstone, with some shale in part silicified, and a few beds of conglomerate. The strata measure 5700 ft. in thickness. A wide belt of meta-andesite, which is mapped as a Carboniferous meta-volcanic (Cv) separates the Arlington formation from the overlying Shoo Fly formation. The latter consists of quartzite overlain by clay slate. A measurement across the strata shows a thickness of 6800 ft., but the stratification is obscure in places, and the measurement may be too high. The Peale formation consists of reddish to brown slaty shale, sometimes gray to greenish, passing into tuffaceous sandstone and fine conglomerate. Thin beds of quartzite occur, and masses of black, gray, and red chert form prominent ledges. The thickness is 1400 ft. The Robinson formation consists of a succession of variable sediments ranging from shale to conglomerate, and composed chiefly of igneous material, with occasional lentils of limestone. The most characteristic portion is a gray sandstone which weathers reddish brown. The thickness is 1150 ft. The relative ages of the Arlington, Shoo Fly, Peale, and Robinson formations were found to be in the order named by Diller, who collected many fossils. The Arlington is the oldest.

In the work done by Turner south of the fortieth parallel, in the Bidwell Bar and Downieville quadrangles, the Carboniferous sediments were not separated into as great a number of members, and very few fossils were found. In some isolated masses no fossils were found, and it is possible that some sediments not Carboniferous in age are included. Due to the intrusion of granitic rocks, in places the sediments show much alteration to micaceous slates and mica-schists. Interbedded tuffs are altered to greenstones. Some quartzite and limestone are included.

Triassic (Tr)

Triassic marine meta-sediments include the Hosselkus limestone and the Swearinger slate. The Hosselkus limestone is dark blue on fresh fracture but weathers light gray, and contains a few veins of

white calcite. It is thin-bedded and decidedly slaty, and forms prominent ledges on the divide between Genessee Valley and Hosselkus Creek. The greatest thickness in the Taylorsville region is 140 ft., but greater thicknesses are found to the northwest in the Redding quadrangle. Apparently no measurements have been made in the large area shown in the northern part of Plumas County in the Lassen Peak region.

The Swearinger formation is composed chiefly of dark slaty shale, with thin beds of limestone and chert forming a small proportion of the whole mass. The stratigraphic thickness is 200 by 400 ft. in the Taylorsville region.

Jurassic (Jml)

Middle and Lower Jurassic meta-sediments have been separated by Diller, in the Taylorsville region, into seven formations. The Trail formation is the oldest, then follow the Hardgrave sandstone, Thompson limestone, Mormon sandstone, Bicknell sandstone, Hinchman tuff, and Foreman formation in regular succession. The Thompson limestone is described in some detail on a later page under the heading: "Limestone." The other formations include gray, slaty shales, red, brown, gray to black sandstones, conglomerates and tuffs; and will not be described in further detail here. To the north of the Walker mine the Trail formation has been altered along the granitic intrusion to hornfels, a hard, very fine-grained, black, brittle rock showing traces of schistose structure and the development of garnets. These Jurassic rocks are of interest chiefly because they have been overturned in the folding of the mountains, and the older formations are now on top of the younger. This is one of the few places in the Sierra Nevada where Jurassic sediments have been preserved from erosion. Under this heading is included the Milton formation mapped by Turner in the Downieville quadrangle. It is composed of tuffs, fragmental greenstone, red slates and a little marble.

Tertiary (Tg)

Tertiary auriferous gravels include the remnants of river-beds in which gravel was deposited in Tertiary time. They are now at much higher elevations than when deposited, due to the uplift of the Sierra Nevada in the Tertiary. The large body of gravel to the north apparently marks the place where the northerly flowing Jura River entered an estuary connecting with the sea in the Sacramento Valley region. Shore terraces in these gravels have been identified by Diller on Diamond Mountain. The late Tertiary was marked by great volcanic activity; and the upper strata are composed of boulders and pebbles of lava, in contrast to the lower portions, which are rich in quartz pebbles. Some Quaternary gravel may be included under this heading.

Pleistocene Lake Beds (Ql)

That Meadow Valley and Mohawk Valley were formerly occupied by lakes is indicated by terraces of gravel and sand found above them; hence they are mapped under this heading. Terrace gravels of Meadow Valley have been mined for gold.

Glacial Deposits (Qg)

Deposits of poorly sorted angular boulders, gravel, sand and silt deposited by former glaciers are mapped under this heading. The largest area is near Johnsville, where the morainal deposit is hundreds of feet thick.

Alluvium (Qal)

Flood-plain and valley deposits of soil, sand, and silt are mapped under this heading. Some of the large valleys so mapped were probably formerly occupied by lakes, such as Indian Valley.

Igneous Rocks

pre-Devonian (pDv)

In the Taylorsville region is a large body of gray siliceous meta-rhyolite containing phenocrysts of quartz or feldspar embedded in a uniformly fine, compact groundmass. Much of it has a schistose structure. The Grizzly formation (Silurian) rests on this meta-rhyolite and contains pebbles of it. The quartz porphyry mapped by Turner in the Downieville is apparently the same; and both are mapped as pre-Devonian meta-volcanics.

Carboniferous (Cv)

As Carboniferous meta-volcanics are mapped diabase, porphyrite, and augite-porphyrite of the Lassen Peak and Downieville quadrangles, and the Reeve, Kettle, and Taylor meta-andesites of the Taylorsville region. They are light green crystalline rocks, or greenstones, originally consisting largely of feldspar and augite or hornblende. The dark minerals are now altered to green uralite, epidote and chlorite. They represent lava flows and tuffs laid down in Carboniferous time; also some dikes.

Jurassic Ultra-basic Intrusives (Jub)

Peridotite and pyroxinite, dark green rocks containing pyroxene, hornblende, and olivine, and their alteration product, serpentine, a light to dark green, softer, greasy appearing rock, are mapped under this heading. Lenses of chromite have been found in this formation.

Jurassic Basic Meta-igneous Rocks (Jbi)

The areas mapped as amphibolite by Turner are shown under this heading. He included various altered rocks containing green uralite (hornblende); also greenstones formed from lavas and tuffs, amphibole schist, epidote schist, and metamorphosed diorites.

Jurassic Acid Intrusives (Jai)

Under this heading are grouped the granitic rocks that form the core of the Sierra Nevada—granodiorite, quartz-diorite, quartz-monzonite, and diorite. These rocks crystallized at great depths, and where they are now exposed at the surface, it is certain that thousands of feet of overlying rocks have been eroded away.

Undivided Cenozoic Volcanics

All Tertiary and recent lavas are shown under this heading—rhyolite, dacite, andesite, and basalt. The main vents from which lavas flowed into the area mapped were in the Lassen Peak region, but there were other vents along the Sierra Nevada, such as Mt. Ingalls.

Mineral Deposits.

Gold was the attraction that first drew explorers into Plumas County, and it was found and mined in large quantities, first on a small scale by means of the pan and rocker of the individual prospector and miner, later on a large scale by mining companies employing the hydraulic method. The hydraulic mines washed a tremendous quantity of gravel from the mountains into the streams during the years from 1870 to 1883. The resulting debris became so troublesome to the farming interests that court decisions were made and laws were passed which prohibited the washing of tailings into the streams. In March, 1893, the Caminetti Act was passed by congress to enable hydraulic mines to operate behind dams for restraining the tailings or debris. The restrictions, however, are so severe, and the length of time that a license to operate will remain in force is so uncertain that very little mining has been done under the Caminetti Act. Bradley [1] has recently reviewed this entire matter in connection with the proposed construction of dams for the storage of debris from hydraulic mining on the American, Yuba and Bear rivers. If this problem of debris control can be worked out, hydraulic mining can be resumed in the northern Sierra Nevada on many gravel deposits known to contain gold.

When forced to cease mining by the hydraulic method, some of the operators proceeded to mine the richer portions of the deposits by the underground or drift method. The richness of deposits must be many times as great, however, to return a profit by underground mining because of the higher cost. Drift mining is used also to reach the many ancient channels that remain buried under hundreds of feet of lava.

Quartz veins containing gold have been mined in various parts of Plumas County, particularly in the Seneca, Greenville, Crescent Mills, Johnsville and Spring Garden districts. A new productive district has been opened up recently with the construction of a mill near Virgilia, described in detail below under the heading "Virgilia Mining Corporation." The New York mill, near Greenville, has been thoroughly modernized and is producing. There is also some production of gold from the Plumas-Eureka mine at Johnsville. These and smaller productive mines are described in detail on the following pages.

In recent years the principal mining in Plumas County has been copper mining, with the Engels mine producing at the rate of 1000 tons per day, and the Walker mine equipped to treat as much as 2000 tons per day. Since our last report the Engels mine has been shut down and dismantled, but the Walker mine is again in operation after a shutdown.

[1] Bradley, Walter W., Dams for Hydraulic Mining Debris: California State Mineralogist's Report XXXI, pp. 345-367, 1935.

In addition to copper and gold, Plumas County has produced barite, chromite, granite, lead, lime, limestone, manganese, molybdenum, platinum, and miscellaneous stone. These are described in further detail herein, each under its separate heading, and the amount of yearly production is given in the accompanying table.

MINERAL PRODUCTION OF PLUMAS COUNTY, 1880-1935

Year	Copper		Gold, value	Silver, value	Manganese		Miscellaneous stone,[1] value	Miscellaneous and unapportioned		
	Pounds	Value			Tons	Value		Amount	Value	Substance
1880			$857,124	$181						
1881			1,350,000	2,000						
1882			1,250,000							
1883			950,000							
1884			900,000							
1885			840,308							
1886			834,452	62						
1887			698,069	16						
1888			650,000	250						
1889			796,754	235						
1890			490,664	811						
1891			482,462							
1892			432,295	11,731						
1893			362,488	14						
1894			499,359							
1895			602,951	271						
1896			462,527	83						
1897			339,252	701						
1898			369,609							
1899			381,151	15						
1900			365,210	4,159	1	$10				
1901			401,287	2,508	2	40				
1902			360,686	517						
1903	1,900	$247	424,112	510	1	25				
1904			270,439	464						
1905	1,006	157	283,810	530						
1906			229,350	1,055	1	30			$25	Platinum.
1907			219,355	948	1	25	$5,000			
1908			254,737	3,560	1	25				
1909			157,491	587	3	75	2,000		75,575	Unapportioned, 1900-1909.
1910			187,207	1,038	5	75	12,500	1,115 lbs.	50	Lead.
1911			228,785	1,125	2	40		1,329 lbs.	60	Lead.
1912	6,963	1,149	193,237	957	2	40	1,350	5,856 lbs.	264	Lead.
1913	[3]19,533	3,028	138,368	705			1,700	5,621 lbs.	247	Lead.
1914	[3]169,089	22,489	140,000	2,900			1,879	2,058 lbs.	80	Lead.
1915	3,164,496	553,787	167,440	19,025			5,431		32	Other minerals.
1916	4,932,928	1,213,500	133,385	46,542			1,988		3,920	Chromite, granite, molybdenum.
1917	7,462,870	2,037,364	131,955	74,461	1,540	39,680	1,322	473 tons	9,800	Chromite.
									304	Gems, granite, silica.
1918	11,098,016	2,741,210	125,207	156,750	1,544	61,754	7,750		23	Other minerals.

1919	10,193,951	1,896,075	83,600	175,846	(2)		850		1,825	Limestone, manganese.
1920	9,583,834	1,763,425	102,097	153,373			62,109		2,658	Granite, lead, lime, platinum.
1921	11,584,216	1,494,364	127,148	171,090			(2)	2,961 lbs. 18 fine oz.	133 1,615 4,111	Lead. Platinum. Granite and miscellaneous stone.
1922	20,677,771	2,791,499	223,025	297,254					2,720	Granite, platinum, miscellaneous stone.
1923	22,883,609	3,363,891	174,871	243,970			780		750	Other minerals.
1924	25,557,362	3,348,015	277,571	247,569					2,950	Chromite, granite.
1925	26,950,029	3,826,904	249,540	294,254					30,810	Chromite, granite, manganese ore, miscellaneous stone.
1926	22,163,035	3,102,825	247,667	216,620					5,516	Granite, lead, manganese ore, platinum.
1927	21,055,425	3,758,261	321,016	179,108					2,338	Granite, lead, lime.
1928	21,141,121	3,044,321	332,634	191,134			28,124		2,914	Granite, lead, manganese.
1929	25,253,603	4,444,634	391,683	271,712			80,420		3,520	Granite, lead, manganese.
1930	19,529,224	2,538,799	405,359	164,025			106,900	491 lbs.	25 4,792	Lead. Granite and manganese.
1931	12,473,960	1,135,130	308,443	93,472			20,250		2,001	Granite and lead.
1932	1,043,390	65,734	76,781	8,180			20,000		10,617	Barytes, granite, platinum.
1933	(2)		70,000	402			51,125		9,623	Barytes, copper, granite, lead.
1934	773	59	153,056	718			(2) (2)	1,111 lbs.	110 27,200	Lead. Barite, granite, miscellaneous stone.
1935	1,654,113	137,291	207,856	34,402			15,054	1,331 lbs.	53 19,860	Lead. Barite and granite.
Totals	[3]278,602,217	$43,284,158	$21,733,873	$3,077,840	[3]3,103	$101,819	$426,532		$226,518	

[1] Includes crushed rock, rubble, rip-rap, sand, gravel.
[2] See under 'Unapportioned.'
[3] Includes copper erroneously credited to Lassen County in those years, on account of shipping point being Doyle, though the mines were located in Plumas County.

BARITE

Savercool Mine is a property of four patented claims, includng the Kansas Extension, Lot 50, and the North Fork Extension, Lot 51, in Sec. 5, T. 26 N., R. 8 E., owned by Kenneth Murray of Greenville and others. The property is leased to J. L. Warner, Box 1533, Reno, Nevada, for whom S. S. Terry is mining engineer.

The property adjoins that of the Synthetic Iron Color Company (which see). The strike of the lens of barite is not the same, however, being N. 30° W. The dip is to the west. Apparently the lens is not continuous with the one being mined by Synthetic Iron Color Company. When visited it was cut in three or four places with trenches in a total length along the strike of 200 ft. Widths of 10 ft. were exposed, and it is possible that additional trenching will expose double that width. A short time after this property was visited the lessee built a short stretch of road that was needed to reach the deposit from the road used by the Synthetic Iron Color Company; and a carload of the barite was mined and shipped as a sample. The shipping point is Almanor siding on the new line of the Western Pacific, five miles from the property.

Synthetic Iron Color Company owns six unpatented claims, including the Ohio and the Ohio Extension in Sec. 5 T. 26 N., R. 8 E., and Sec. 32, T. 27 N., R. 8 E. N. M. Zoph, Box 1157, Richmond, California, is president, and D. R. Irving, Greenville, California, is superintendent at the mine.

Barite has been mined here for about five years, partly in open pits, partly underground using square sets. The lens of barite is 175 ft. long by 60 ft. deep by a maximum of 30 ft. wide, striking north and south and dipping 45° to 50° west. The lens has walls of slate, and is interstratified with the slate to a slight extent on the walls. Occasional chunks or horses of quartz or chert occur in the barite. The best barite is not stratified.

During the summer of 1936, ten men were at work mining the barite and hauling it in two trucks to Almanor station on the new line of the Western Pacific, five miles distant. Truck-loads averaged 3¾ tons each. The operators expected to mine the last of the barite in this lens during the summer of 1936. The total production from the lens is approximately 17,000 tons. Shipments have run 94% to 95% $BaSO_4$.

CHROMITE

The occurrence of chromite has been noted in Plumas County in State Mineralogist's Report XVI,[1] and in State Division of Mines Bulletin No. 76 [2]. Production from the following two properties has been noted in the publications cited.

McCarty (Jitney) chrome property in Sec. 14, T. 23 N., R. 9 E., 10 miles southwest of Quincy, was reported in Bulletin 76 to have in sight 300 tons of ore, running from 45% to 48% Cr_2O_3, and 45 tons of ore of that grade had been shipped.

Valley View chrome property, near Greenville, was reported to have produced two carloads of chromite, running 32% Cr_2O_3.

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[1] MacBoyle, Errol, Mines and Mineral Resources of Plumas County: State Mineralogist's Report XVI, p. 54, 1918.

[2] Manganese and Chromium in California, State Division of Mines Bulletin No. 76, pp. 165, 166, 1918.

Serpentine occurs in rather large masses at a number of places in the western part of Plumas County, and it is probable that chromite can be found in many places associated with this serpentine. Some of the areas are rather inaccessible, however. During the field season of 1936 chromite was noted as follows:

Gold Stripes Mine in Sec. 36, T. 27 N., R. 8 E., is one of two properties of this name held by B. K. Melville, 581 56th Street, Oakland, California. These two properties are described further under the heading "Gold." A serpentine dike outcrops along the western side of the property and a pile of 30 to 40 tons of chromite was noted there. Shallow surface cuts nearby apparently indicate where it was mined. A rough estimate of its grade by eye only is 40% Cr_2O_3.

Near the road between the above *Gold Stripes* and the *Riodel* two similar piles of mined chromite were noted. The ownership of these is not known.

COPPER

A large number of copper prospects have been opened up in Plumas County, but due to the recent low prices of copper, most of them have been inactive for some years. They will be found listed with references to earlier reports on them in the accompanying table of mines. At the following properties, recent developments of interest were noted during the field season of 1936.

Consolidated Gold and Metals Company, J. R. Walker, president, 405–406 Newhouse Building, Salt Lake City, Utah, holds a property said to consist of 59 claims, of which 11 are patented, in Sec. 1, 11, 12, T. 24 N., R. 11 E. At the Assessor's office in Quincy the record shows that 127 acres of patented claims are assessed to this company, address: 20 P.O. Place, Salt Lake City, Utah. In 1932, some development work was done on the property and a composite of 13 samples was stated to have given an assay of $5.07 in gold and 2½ ounces in silver per ton; also 4.06% copper. When visited in 1936, this property had apparently been idle for a number of years. The dump at the upper adit level indicated that at least several hundred feet of work had been done there. Some of the ore set aside in a separate dump shows considerable quantities of malachite and azurite. No equipment remains except buildings to accommodate roughly 10 men and an old air-compressor. This property was formerly known as the *Walker Consolidated.*

Copper Bullion is a property of nine claims on the north side of Union Creek, one mile above where it flows into Nelson Creek, probably in the unsurveyed Sec. 34, T. 23 N., R. 10 E. Fred Wickstrom and A. Mattson, of Quincy, first opened up this property in 1930. It is reached by several miles of trail from Onion Valley, and was not visited. The owners state that there is a 20-ft. shaft on a quartz vein carrying gold. A dike 12 ft. wide with 3 ft. of quartz on the footwall is said to assay $4.00 per ton across the entire width of the shaft. There is also a 30-ft. tunnel on copper ore carrying chalcopyrite, which the owners state has given assays from 2% to 25% in copper.

Engels Copper Mine in Sec. 32, 33, 34, T. 28 N., R. 11 E. and Sec. 3, 4, 5, 8, 9, 10, 15, 16, 17, 19, 20, T. 27 N., R. 11 E., is no longer operat-

Panorama of mill and camp of Walker Mining Co.

ing, and the equipment is being sold. The Indian Valley Railroad with terminus at the mine is still in operation. In addition to descriptions of past operations contained in Reports of the State Mineralogist, references to which are to be found in the accompanying table of mines, a number of other papers [1] have been written on these deposits, and the reader is referred to them. Plans to re-open this mine were reported in 1937.

Iron Dike Mine is a property of six claims in Sec. 2, T. 25 N., R. 10 E., just south of the town of Taylorsville, held by F. D. Beardsley, 49 King Street, Santa Cruz. McBoyle [2] states that this property was operated in 1860 through the Pettinger shaft and that it was purchased by the Sierra Range Copper Company, Sioux City, Iowa, in 1905. He also describes some of the other early workings.

When visited in 1936, the property was idle, but some new work had been done from a tunnel that starts at creek level. This tunnel runs in an easterly direction and strikes four veins, the first at 350 ft., the second at 400 ft., the third at 450 ft., and the fourth at 500 ft. On the second vein there is a drift in a southerly direction for 300 ft. On this vein George Sobrero, of Taylorsville, has recently put up a raise for 30 ft. and he estimates that he has 30 ft. more to go to break into an old glory hole roughly 35 ft. deep. This vein shows a width of about 18 inches of sulphides of iron and copper in the raise. The third vein shows 4 ft. to 5 ft. of quartz containing chalcopyrite. A shaft was put down on this vein for 50 ft. in about 1928, but it is now full of water. The second and the third veins have an easterly dip of about 60°, while the fourth vein, which is more of a shear-zone, dips to the west. Country rock is a very fine-grained greenish-gray rock, probably meta-andesite.

The property is equipped with a 12-inch by 10-inch Chicago Pneumatic single stage air-compressor, and a Roots blower for ventilation. Electric motors are on hand to drive these, but connection has not been made to the power line.

References to earlier reports on this mine are to be found in the accompanying table of mines.

Walker Mining Company, 818 Kearns Building, Salt Lake City, Utah, operates the largest copper mine in California at present. It is controlled by Anaconda Copper Company, and International Smelting and Refining Company. J. R. Walker is president and J. B. Whitehill, secretary-treasurer. The local postoffice is called Walkermine. H. A. Geisendorfer is manager there; W. T. Benson, chief engineer; S. K. Droubay, geologist; and Ralph Hayden, mill superintendent.

The company owns some 301 mining claims, of which 200 are patented. The main camp is located in Sec. 7, T. 24 N., R. 12 E., and the balance of the property is in surrounding sections in the steep,

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[1] Turner, H. W., and Rogers, A. F., A geologic and microscopic study of a magmatic copper sulphide deposit in Plumas County: Econ. Geology, Vol. IX, No. 4, 1914.

Read, Thos. T., The Engels Mine and Mill; Min. and Sci. Press, Vol. III, p. 167, 1915.

Graton, L. C. and McLaughlin, D. H., Ore deposition and enrichment at Engles, California: Econ. Geology, Vol. XII, No. 1, January, 1917.

Anderson, Charles A., The geology of the Engles and Superior mines, Plumas County, California, with note on the ore deposits of the Superior mine: Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. XX, No. 8.

[2] *op. cit.*

timber-covered mountains between Little Grizzly Creek and Mt. Ingalls, at elevations varying from 6000 to 7000 feet. A fair mountain road runs from Portola to the mine; also one from Genesee. When both of these are blocked by snow in the winter the nine-mile cable-tramway connecting the mine with the Western Pacific Railroad at Spring Garden is available for the transportation of both freight and passengers. This deposit was discovered in 1904 but important development work was not done until 1915. MacBoyle [1] has described this early work and the old mill in State Mineralogist's Report XVI.

The general geology of this region has been worked out by Diller [2] in an area a few miles to the northwest of the Walker mine. A pre-Silurian metarhyolite found on Little Grizzly Creek is the oldest formation of the area. Overlying this are the Peale formation (Carboniferous) composed of sandstones, shales and some cherts; the Taylor meta-andesite; the Robinson formation (Carboniferous) of sandstones and shales with a few limestone lenses, and conglomerate beds; the Kettle meta-andesite; and the Trail formation (lower Jurassic) of slaty shales with some interbedded sandstones and conglomerates. These formations strike about N. 30° W. in belts from half a mile to a mile wide, and they extend southeasterly from Genesee to the Walker mine. The Trail formation is altered in part to hornfels by the intrusion of the granodiorite, which is exposed over great areas to the northeast, and which probably underlies the entire region. Ewing [3] provisionally assigns the wall-rocks of the Walker veins to the Trail formation. However, the alteration of these rocks is so great that little remains to indicate what they originally were. The Robinson formation is also a possibility. To the east are great exposures of post-mineral basalt.

One of the most remarkable things about the Walker vein system is the barren-appearing outcrop. For thousands of feet this outcrop of quartz, in places with barite, looks quite barren, but just below are important orebodies. Sections of these have already been mined right up to the oxidized zone, which is roughly 50 ft. deep. At the point of the original discovery, the vein has been mined to the surface, and the outcrop can no longer be seen. It was probably better here, for a few hundred feet, but this is only a fraction of the length of the vein system.

The main haulage level is the seventh level adit, more than two miles in length. Vertically, it is 900 ft. lower than the highest point on the outcrop, or 1200 ft. on the dip of the vein. This adit is a crosscut for 3000 ft. passing through a post-mineral intrusion of granite, which limits the vein on the south. The adit then turns and follows the shear zone in which the ore occurs. It develops the South, the Central, the North, the 712, and the Piute orebodies, which vary from a few hundred feet in length to 2000 ft. Between them are portions of the shear zone varying from a few hundred feet to 1000 ft. in length, which carry some copper, but not enough to be considered ore at the present price. The strike is N. 20° to 30° W. and the dip 50° to 75° E. The Piute orebody, which is farthest north, has a minable width of 100 ft. (maximum). At some of the other orebodies the entire shear zone cannot be mined, but

[1] MacBoyle, Errol, State Mineralogist's Report XVI, pp. 63, 64, 1918.
[2] Diller, J. S., Geology of the Taylorsville Region, California: U. S. Geol. Survey Bull. 353, 1908.
[3] Ewing, Sydney C., Geology and ore-deposits of the Mt. Ingalls District, Plumas Co., California: unpublished thesis submitted at Leland Stanford Junior University for master's degree, 1927.

a certain streak, say 10 ft. to 50 ft., of the best grade of ore is selected for mining. Spurs consisting of quartz ore with a minable width sometimes as great as 12 ft. or 15 ft. are found running at a considerable angle to the main shear zone out into the footwall. It is thought that many of these exist, and that they will be found as development proceeds.

The country rock is typically a fine-grained, dark (almost black) schist (or hornfels) formed by the action of the igneous intrusions on a sedimentary series. It contains quartz, feldspar, enstatite, biotite and garnet. All of the wall-rock contains a little copper even at a considerable distance from the vein. At the Piute orebody, which is farthest to the north and hence removed from the influence of the granitic intrusion that limits the vein on the south, traces of the original sedimentary beds are seen, making an angle in both strike and dip with the shear zone in its center. The hanging-wall and the footwall are marked by gouge seams nearly a foot thick, and near them the bedding is dragged in such a way as to parallel the gouge. In the orebodies to the south this gouge on the walls is lacking. Ewing [4] leaned to the magmatic injection theory in his discussion of the genesis of this vein system. His ideas were based on an examination of the orebodies near the granitic intrusion. The appearance farther north is quite different.

The ore varies from white quartz containing massive chalcopyrite, through all stages of replaced country-rock, to country-rock with seams of chalcopyrite a fraction of an inch wide on the planes of shear and fracture.

The approximate percentages of mineral constituents are as follows:

	Per cent
Quartz	75.0
Garnet	5.0
Chlorite	2.5
Other nonopaque minerals	5.0
Metallic minerals	12.5
Total	100.0

The metallic minerals, which as stated amount to 12.5 per cent of the ore, are distributed as follows:

	Per cent. by weight	
Magnetite	59.76	
Pyrite	7.80	
Pyrrhotite	1.94	
Minor metallic gangue minerals	1.10	
Total metallic gangue minerals		70.60
Chalcopyrite	24.17	
Chalcocite	1.60	
Minor copper-bearing minerals	2.55	
Noncopper-bearing minerals	1.08	
Total metallic ore minerals		29.40
All metallic minerals		100.00

[4] *op. cit.*

Minor metallic minerals include sphalerite, galena, tetrahedrite, stibnite, jamesonite, and free gold.

The mine is well developed to the 10th level, and some stoping is being done below the adit level, to which the ore is hoisted. However, most of the production comes from above the 7th level adit or main haulage level. Levels are roughly 150 ft. apart vertically or nearly 200 ft. on the dip of the vein. A winze being sunk in the footwall from the 10th level was down 70 ft. in July, 1936. At the Piute orebody, the elevation of the 7th level is 6220 ft. and that of the 10th level is 5722 ft. Ore is mined by shrinkage stoping. Sub-levels are driven about 30 ft. higher than the 7th level, grizzleys are placed over

Froth on Callow flotation cells in mill of Walker Mine.

main chutes, and finger raises are driven above grizzleys, to open the stopes. Electric locomotives haul trains of cars holding 3 tons each through the 7th level adit to the coarse-ore bin at the mill. In July, 1936, the number of men at work was 365.

The milling methods of the Walker Mining Company have been described by M. R. McKenzie [5] and H. K. Lancaster in information circular No. 6555. The flow sheet given in that publication is practically up to date and it is reproduced herewith. The only important change is that the middling from the Callow rougher machines is cleaned in four Callow cells before being returned to the Flotation feed. Two cells are used to clean the concentrate as shown on the flow sheet. Information circular 6555 shows that potassium ethyl xanthate (Z-3) is used in

[5] McKenzie, M. R., Lancaster, H. K., Milling methods at the concentrator of the Walker Mining Company, Walkermine, Cal.: U. S. Bur. Mines. Inf. Circ. 6555, March, 1932.

the flotation machines. This reagent is still in use but it has been found that xanthate Z-8 gives a better recovery of gold, and it is probable that the latter will be substituted. The mill was treating an average of 1200 tons of ore per day at the time of our visit (July, 1936). Grinding is to 9% on a 48-mesh screen.

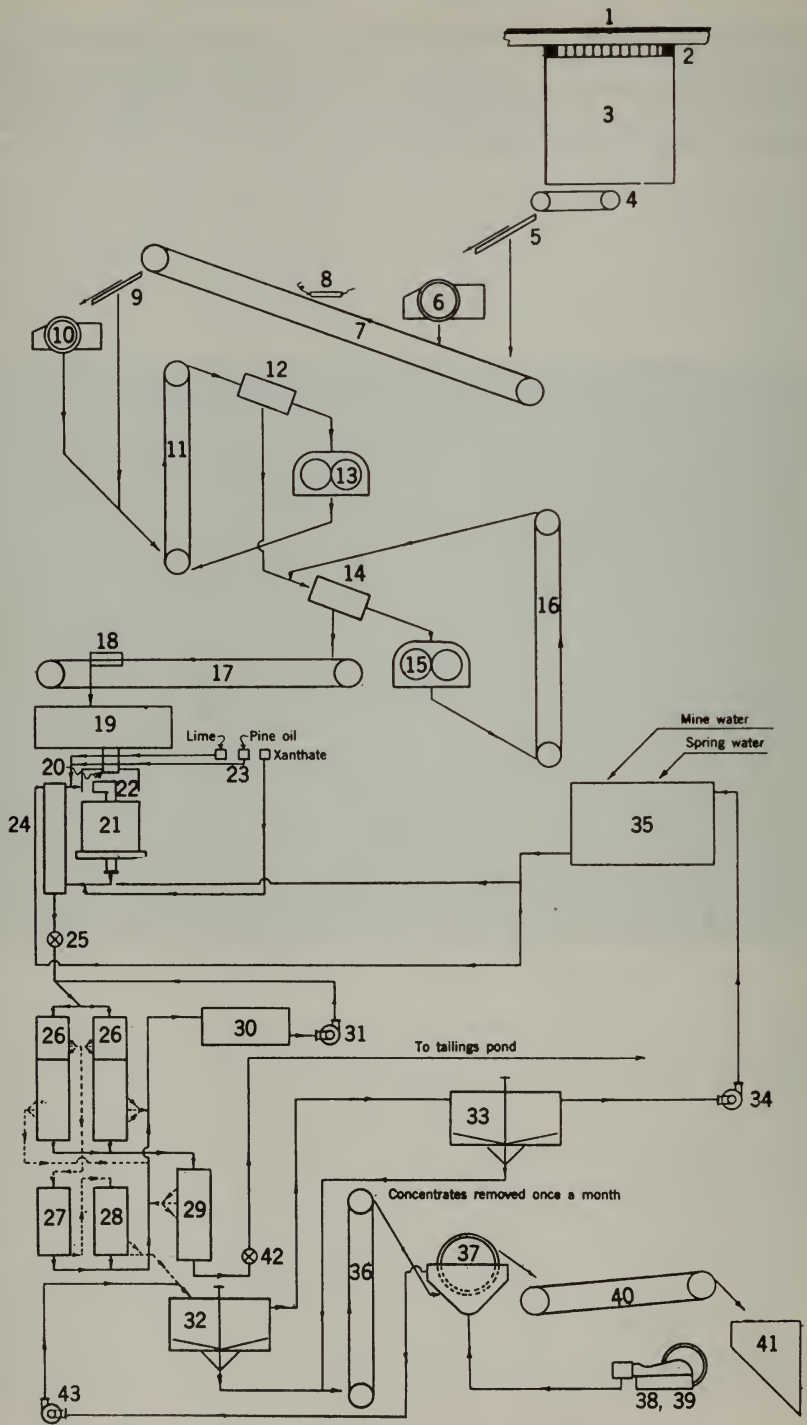


FIG. 1. Flow sheet of crushing plant and concentrator, Walker Mining Co.

Legend for Flowsheet of Crushing Plant and Concentrator

Number[1]	*Description of machines*
1	Track from mine.
2	One grizzly, 11-inch spaces.
3	Ore bin, 1500-ton capacity.
4	One pan conveyor, 42-inch.
5	One grizzly, 1½-inch spaces.
6	One Traylor jaw crusher, 15 by 24 inch.
7	Belt conveyor, 20-inch.
8	Electromagnet.
9	One grizzly, 1¼-inch spaces.
10	Two Anaconda jaw crushers, 8 by 20 inch.
11	One bucket elevator, 16-inch.
12	One trommel screen, 1¾-inch holes.
13	One set Anaconda rolls, 24 by 55 inch, set at 1-inch.
14	Two trommel screens, 1-inch holes.
15	One set Anaconda rolls, 24 by 55 inch, set at ⅜ inch.
16	One bucket elevator, 16-inch.
17	One belt conveyor, 20-inch.
18	One tripper conveyor.
19	Fine-ore bin, 2400-ton capacity.
20	Four feed conveyor belts, 18-inch.
21	Four Marcy ball mills, three No. 75 and one No. 77.
22	Four scoop boxes.
23	Reagent feeders.
24	Four Dorr duplex classifiers, three 6 feet by 18 feet 4 inches and one 6 feet by 23 feet 4 inches.
25	One Galigher sampler for heads.
26.	Eight Callow rougher flotation machines, two 3-foot 11-pan units per mill section.
27	Four primary Callow cleaner machines, one 3-foot 4-pan unit per mill section.
28	Four secondary Callow cleaner machines, one 18-inch hoppered type unit per mill section.
29	Two Callow scavenger machines, 3-foot 7-pan units.
30	One middlings sump, tank capacity 2000 gallons.
31	Three Krogh pumps, 3-inch.
32	Two Dorr concentrates thickeners, 12 by 25 foot.
33	One Dorr thickener, 11 feet 4½ inches by 46 feet.
34	One centrifugal pump, 3-inch.
35	Water storage tank, capacity 100,000 gallons.
36	One bucket elevator, 16-inch.
37	One Oliver filter, 12 by 8 foot.
38	One Oliver vacuum pump, 14 by 8-inch.
39	One Oliver compressor, 9½ by 8-inch.
40	One belt conveyor, 18-inch.
41	Concentrates storage bin, 290-ton capacity.
42	One Galigher automatic sampler for tailings.
43	One centrifugal pump, 1½-inch.

[1] Refer to numbers of Figure 1.

The Walker mine was shut down from February, 1932, until the fall of 1935. In September, 1935, the mill was started and 500 to 600 tons of ore per day were treated. This has now been increased to 1200 tons per day. The last full year's operation was in 1931, and the following information is quoted from the annual report to stockholders for that year:

The mine operated 289 days during the year, part of the time on a basis of six days per week and part on a basis of five days per week, to curtail production. Average production per day was 1494 tons of ore and 16.8 tons of waste. After smelter deductions have been made the mine was credited with the production of 11,952,440 lbs. of copper, which after crediting the value of the gold and silver cost 8.8325¢ per lb. including development work. The latter with some miscellaneous charges cost $99,523.41 or $12.722 per foot on 7823 ft. New construction and equipment cost $18,731.19.

Tramway terminal at Spring Garden, Walker Mining Co.

Operating costs per ton of crude ore for breaking, producing, milling and delivery of concentrates to Spring Garden were as follows:

	Tons	*Amount*	*Cost per ton*
Breaking, including development	424,452.00	$428,907.86	$1.0105
Producing	440,558.00	200,119.25	.4542
Total breaking, development and producing	429,486.88	$629,027.11	$1.4647
Milling	432,294.00	235,341.04	.5444
Tramway 25,613.105 tons concentrate at average concentration ratio of 17.0853	436,916.00	16,145.97	.0370
Totals	430,348.00	$880,514.12	$2.0461

Breaking at $1.0105 per ton includes $0.2157 per ton for development.

Concentration Department, 1931.

Ore milled, dry tons	432,294
Average grade heads, % copper	1.6317
Average grade tailing, % copper	0.1648
Average copper recovery, %	90.49
Average grade concentrate, % copper	25.187
Average grade mill heads, ounces silver	0.926
Average grade mill heads, ounces gold	0.0516
Dry tons concentrate produced	25,342.1

For references to earlier reports on this mine see accompanying table of mines.

GOLD

Browns Hill Mines in Sec. 29, 30, T. 22 N., R. 8 E., are near Cascade close to the southwestern county line between Plumas and Butte counties. The postoffice serving the district is Feather Falls in Butte County. A rough mountain road 18 miles long reaches the district from La Porte, and it can also be reached from Oroville. A. P. Linville, 1701 Allston Way, Berkeley, owns 40 acres of patented land in the SE¼ of the SE¼ of Sec. 30; also six unpatented mining claims, the Crystal Gold, Crystal No. 2, Browns Hill Billy, Plumas King, Plumas Queen and one other. The patented ground is a part of the George McMillian homestead.

On Crystal Gold are two tunnels 70 ft. long and 119 ft. long, respectively, with 50 ft. difference in elevation. They follow a quartz vein striking S. 12° to 35° W., with a dip of 57° to the west. The width in the lower tunnel varies from 0 to 2 ft. and in the upper tunnel it swells to a greater width than is exposed by the tunnel, which is 6 ft. wide. Country rock is a fine-grained green rock mapped by Turner [1] as amphibolite. A narrow, fine-grained, decomposed dike along the footwall of the vein contains cubes of pyrite with edges about a millimeter long. On the Browns Hill Billy claim, roughly 400 ft. to the east of the tunnel on the Crystal Gold, is a cut 20 ft. long and 4 ft. deep, showing a width of 4 ft. to 8 ft. of white quartz striking N. 50° E. and dipping 80° NW. At a point 200 ft. farther to the east is a shaft seven feet deep on a parallel vein about a foot in width. All of this quartz carries some free gold and a small percentage of pyrite.

The frame for a mill building has recently been erected at the lower (119-ft.) tunnel, 12 ft. by 40 ft., designed to house a Straub ball mill with capacity of five tons per 24 hours.

The Mary Ann Mine adjoins.

Bunker Hill Mine in Sec. 15, 16, T. 22 N., R. 10 E., is on the old system of Tertiary channels of the Gibsonville-LaPorte region. According to McBoyle [2] about a mile of this channel was worked in the years from 1875 to 1895, under the lava-capped Bunker Hill ridge. The *Niagara Consolidated Mining Company* did most of the work.

The mine is now being operated by the *Sierra Nevada Mining Corporation;* C. S. Haley, president; Frank Hurlbutt, secretary, New York; main office, Charleston, West Virginia. The mine address is

[1] *op. cit.*
[2] *op. cit.*

LaPorte. From the main adit level at the 2500 ft. point, raising is being done to gravel 40 ft. above the adit level. There are two gravel channels here, separated by a 30-ft. thickness of clay-like material locally called andesite, which probably was originally a volcanic mud-flow. Above this is a channel which contains largely white quartz. The lower channel in which present work is being done is roughly 400 ft. wide at the bottom, but a width of 2000 ft. is indicated at the surface. It strikes a little east of north and the flow was a little to the west of south. The upper, or North American channel, slopes northwest and probably makes a turn to the west in the property of the Bunker Hill mine. A portion of the lower channel has recently been breasted out from inclines below the main adit level.

The mine is equipped with a 375 c. f. m. gasoline-driven compressor and a 15 kw. gasoline-driven generator, which supplies current for lights, ventilating fan and shop tools. There is a washing plant capable of handling 500 cu. yds. per day during periods of plentiful supply of water. Below this plant is a Huelsdonk concentrator. At time of visit 10 men were at work.

Butterfly Group of six claims in Sec. 27, 33, T. 25 N., R. 9 E., is owned by Smith Bros. of Quincy. C. E. Smith and A. L. Smith are working the Blue Point vein. From a 250 ft. drift-adit, a 22-ft. raise has been driven on the vein at a point 110 ft. from the portal. The face of the raise shows a width of four feet or more of ore that the operators state assays $7 to $8 per ton in gold. There are 80 ft. of backs above this adit level, and the vein widens toward the surface. The strike of the vein is northwest and southeast, and the dip is vertical. Both walls are slate.

At a distance of 1000 ft. to the southwest of the Blue Point vein is a second vein that has been opened in three places in a length of 2000 ft. There is a 70 ft. shaft at one end of this length, a 500-ft. cross-cut adit near the center, and drift-adit near the mill. These workings are not in good condition at the present time, and the vein was not seen. It is stated by the operators to show a width of 5 ft. and more of ore assaying $20 per ton in gold. It is a quartz ore containing pyrite, and the gold is not free.

Ore is being milled in a 5-stamp mill of 700-lb. stamps driven by a gasoline engine. Treatment is amalgamation only. Some of these claims date back to 1877; and references to earlier reports on them are given in the accompanying table of mines.

California Gold Fields Development Co., with main office in Wilmington, Delaware, and branch office at Gridley, California, has recently done a little work on a placer property in Sec. 6, T. 26 N., R. 9 E. J. Everett Shelton is president-treasurer, and Calvin Fulk is vice-president. Water for this work was pumped with automobile engines. The *Highland Group* of placer claims of 160 acres, in the same section, has been located by J. Everett Shelton, W. G. Jeffries, Dewey Roe, Clyde Lee, Ralph Mohr and W. W. Stearns.

Canton Placer Mining Co. holds 623 acres of patented ground in Sec. 1, T. 24 N., R. 6 E., and adjoining sections, to cover 11 miles of river-channel from a point near Belden to the confluence of Swamp Creek and North Fork Feather River. Some production is said to have

been made from a spot near Bucks Creek in 1898; and the property is now being sampled. It is assessed to the company named, c/o Mrs. C. C. Coffin, 1990 Marin Ave., Berkeley. Chas. R. Swift, 2737 Elmwood Ave., Berkeley, is said to be president.

Carnation Gold Mining Co., Ltd., see Jamison Mine.

Cherokee Mine of six claims in Sec. 14, 23, T. 26 N., R. 9 E., is being operated by Hinckley Bros. (T. P. & F. W. Hinckley) of Greenville. A new mill contains the following machines: 8-inch by 10-inch Blake type crusher driven by a 10-hp. motor, and crushing ore to ¾-inch size; Denver Engineering ball mill 36-inch diameter by 96 inches long; Dorr 54-inch duplex classifier; 6-cell Simpson flotation machine of the pneumatic type. To supply air for the latter is a Connersville blower, which at 700 rpm. supplies 740 cubic feet of air per minute under a pressure of 4 lbs. per sq. inch. A bin for coarse ore and one for crushed ore, each of 75 tons capacity, are provided. All machines are driven by individual electric motors, which are controlled by thermostats to prevent overheating. This mill is located at the collar of a shaft on a vein known as the Caledonia. It strikes easterly and westerly and dips 65° south. Drifts at the 100-ft. level of this shaft have recently been run out 40 ft. in one direction and 50 ft. in the other. At a distance of 300 ft. to the south of this incline-shaft is a vertical one known as the Kettle shaft, 250 ft. in depth. It is to be pumped out soon. Plans call also for the installation of an air compressor of a capacity of 500 cu. ft. per minute. A new power line, 9000 ft. long, had recently been completed at time of visit, and motors were being installed to replace gasoline engines. Hence the property was not in operation.

Columbia Development Co., see Plumas Quartz.

Consolidated Gold & Metals Co., see under "copper."

Daley Bros. Mine is in Sec. 29, T. 22 N., R. 8 E. near the Browns Hill mines. A production of 75 tons of ore said to assay $96 per ton in gold has recently been made here.

Dixie Queen in the unsurveyed Sec. 33 (?), T. 23 N., R. 10 E. is a claim held by A. Mattson of Quincy on Dixon Creek, 2½ miles from where it flows into Nelson Creek. The owner states that he has found gold at three places in a distance of 300 ft. along the strike of a 7-ft. vein. He has sunk a shaft on it to a depth of 8 ft.

Drader Mine (Plumas National) comprises three claims in Sec. 29, 30, 32, T. 26 N., R. 9 E. Dr. C. S. Drader of Greenville has recently cleaned out a 1230-ft. tunnel, and has driven it ahead for 30 ft. Some encouraging gold-assays have been obtained from the old drift.

Droege Mine in Sec. 9, 10, 15, 16, T. 26 N., R. 9 E., 1½ miles south of Greenville is assessed to Lindblom Investment Co., Hotel Claremont, Berkeley. The mine is credited with a production of $300,000 from three upper adit levels, in years earlier than 1918, according to MacBoyle.[1]

A fourth adit level, 400 ft. lower in elevation than No. 3, has not been productive. Work on cleaning out this level was started, in the

[1] *op. cit.*

fall of 1936, under the supervision of Walter Parsons of Greenville. A number of references to earlier reports on this mine are contained in the accompanying table of mines.

Dutch Hill Mine is in Sec. 8, 17, T. 26 N., R. 8 E., near Seneca. This is an old mine on a high channel of North Fork Feather River that has been worked on and off during a long period of years, first by hydraulicking, then by drifting. Savercool Bros. of Seneca and others are the present owners. The main adit has recently been extended northerly to the 1900-ft. point and a raise of 50 ft. made to gravel. This is a faulted segment of the channel that is buried under a thickness of 100 ft. of lava, and considerable difficulty was experienced in finding it. The gravel is said to contain a very promising amount of gold. The elevation of the portal of the main adit is 4492.1 ft. Two men are at work. References to older reports are contained in the accompanying table of mines.

Five Bears Mining Co., 1105 Guaranty Building, Los Angeles, is a California corporation, of which Everett L. Ball is president. The property consists of 16 claims in Sec. 18 (?), T. 23 N., R. 10 E., four miles below Nelson Point on Middle Fork Feather River. A five-stamp mill was operated for a few months during the winter, 1935–1936. According to Ball, the ore came from a quartz vein averaging 6 ft. to 7 ft. in width for a distance of 300 ft. The mine was idle when fieldwork was done in 1936, and it was not visited. Plans were under way for reopening later in the year under new management.

Glacier Mining Co. (Glazier, *Dominion Mines and Development Co.*) is operating a property in Sec. 9, 16 T. 26 N., R. 8 E., owned by R. C. Foerster, Crocker Building, San Francisco, and Mrs. A. D. McMillan, Seneca. It is reached via Seneca, by a steep mountain road from Lake Almanor. The deposit consists of auriferous gravels in an old channel of North Fork Feather River that is nearly 200 ft. higher than the present stream, and is buried under several flows of lava. W. J. McMillan, of Seneca, is in charge.

The Glazier adit, which starts near the southwest corner of the Glazier No. 2 claim at an elevation of 3696.5 ft., is being run southwesterly at the 2000-ft. point to get under a 1600-ft. portion of a channel in the Cameron claim, on which Glacier Mining Co. has a lease. The adit will be driven 15 ft. farther, then a raise of 28 ft. will be driven to the gravel. In the Glazier ground adjoining this Cameron lease, a 700-ft. length of the same channel has already been breasted for an average width of 100 ft. The depth of gravel mined is 4 ft., and the depth of bedrock is 1 ft., making the height of the workings 5 feet. Gravel mined in this way is stated to have averaged $5 per cubic yard.

To the northeast of the 700-ft. segment of channel already mined out in that direction, measured from the Cameron line, is a 5000-ft. length of channel in Glazier ground. It is planned later to start at the 900-ft. point in the Glazier adit, drive to the surface for a second exit, then drive 700 ft. of adit to get under the channel to the northeast. The adit will be roughly 30 ft. below the gravel in the slate bedrock.

This mine has been described under the name Glazier, in a number of earlier reports, and references to them are contained in the accompanying table of mines.

Golden Gulch is a single quartz claim recently located by C. C. Coffman, Cascade, via Feather Falls, or Box 27820 Niles Road, Hayward. It is in Sec. 30, T. 22 N., R. 8 E. Placer gold has been produced from the little creek on this claim on a small scale, for many years. Coffman has sunk a 10-ft. shaft on a quartz vein, 4 ft. wide, which strikes S. 15° W. and dips 80° W. The quartz contains free gold, shown by panning. The shaft is on the hillside, 100 ft. higher in elevation than the creek. On the opposite side of the creek is an open cut which exposes a quartz vein with the same strike.

Gold Highway is a large group of unpatented claims in Sec. 17, 18, 20, 28, 29, 33, 34, T. 25 N., R. 8 E., and Sec. 2, 3, T. 24 N., R. 8 E., held by R. V. Montgomery, Chemeketa Park, Alma, Santa Clara County, California. The group adjoins the property being worked by Virgilia Mining Corp., and follows the trend of the veins in that property for roughly five miles to the southeast.

Gold Star is held by S. Seaquist, Feather Falls, and is in Sec. 30 (?), T. 22 N., R. 8 E., to the west of the Browns Hill group. The owner has been sinking a 100-ft. shaft on a quartz vein, but the property was idle at time of visit.

Gold Stripes Mine. There is some confusion on account of two adjoining properties of this same name being located in Sec. 36, T. 27 N., R. 8 E., and perhaps running down into Sec. 1 of the adjoining township to the south. One of these properties is held by B. K. Melville, and is described below, together with the supposed reasons for the two properties having the same name.

In Sec. 36, T. 27 N., R. 8 E., is a patented property of 52 acres held by Mrs. Cassie M. Hamilton, Oroville Inn, Oroville, also known as the Gold Stripes, and comprising Jersey, Evergreen, and Wolf Creek claims. Ore is being mined above an adit level by Geo. Neseath and G. H. Brownell of Greenville. A quartz stringer zone in the slate strikes N. 65° W. and dips 47° SW. Widths as great as six feet have been mined. At the 800-ft. point in the adit, a winze has recently been put down to a depth of 85 ft. below the adit. According to Brownell, this is in good ore at the bottom; but the vein pinched to practically a zero-width at the 40-ft. point. Ore now being milled is being stoped from a point a short distance above this winze.

The mill contains a crusher; ball mill 3 ft. long by 5 ft. in diameter; Dorr classifier; and plates for amalgamation. It is stated to be capable of treating 3 tons per hour of oxidized ore, grinding to 40-mesh. Flotation cells were originally installed in this mill, but they are not in use. Mining equipment includes a two-stage Ingersoll air-cooled air compressor. Gasoline engines furnish the power. Only the two men already named are working.

This is an old property, and references to earlier reports on it are to be found in the accompanying table of mines.

Gold Stripe Claim is held by B. K. Melville, 581 56th Street, Oakland, California. Apparently the confusion of name with the property described just above has been the result of the relocation by Melville on July 1st, 1927, of an old claim that was called Gold Stripe, and from which gold was produced many years ago. Apparently this formed a

part of the same group as the patented claims now held by Mrs. Hamilton and the entire group was known by the name "Gold Stripes." However, when the claims were patented, the Gold Stripe claim was not included in the patent and was later allowed to lapse.

B. K. Melville is president of *Peerless Development Company,* a California corporation, which he has organized to work a group of seven claims adjoining the patented ground owned by Mrs. Hamilton. The address of Peerless Development Company is Room 304, 333 Kearney Street, San Francisco. This property was idle when visited in the summer of 1936.

Granite Basin Mining Co. holds some 50 mining claims in Sec. 30, T. 23 N., R. 7 E., and adjoining sections. C. F. Tolman of Palo Alto is president, and H. F. Lynn of Grass Valley is manager. At the mine John Tolman is superintendent and Jack Murray is assistant superin-

Mill of Granite Basin Mining Co. Shaft house in lower left corner.

tendent. The property is reached over five miles of dirt road from Letterbox on the Oroville-Bucks Ranch road.

Some of these claims have been known in the past as *Robinson Mine, Morning Star Mine,* and *Black Bart Mine,* and they were described by MacBoyle [1] under those names. Both the Morning Star and the Black Bart were equipped with mills in 1895, according to State Mineralogist's Report XIII. The mineralization is associated with the contact between granite and an igneous rock of granitic grain, made up largely of ferromagnesian minerals. Turner has mapped this with his "amphibolite," but at the mine it is known as meta-andesite or porphyrite. Geological conditions are probably more complicated than could be mapped by Turner [2] on the small scale that he used, and the possi-

[1] MacBoyle, *op. cit.*
[2] Turner, H. W., U. S. Geol. Survey Atlas, Bidwell Bar folio (No. 43), 1890-94.

bility of a basic igneous intrusion here, that preceded the granitic intrusion, should be considered. Some mineralization is found on this contact, and some mine-workings have followed it, but the chief mineralization seems to be in the granite. Near the shaft of Granite Basin Mining Co. are five parallel fissures in a width of a few hundred feet, on which old adits have been driven.

The 320-ft. shaft, which has recently been pumped out, develops a nearly vertical quartz vein with an average width of 18 inches, striking easterly and westerly. On the lower levels the dip changes slightly and departs a few degrees from vertical toward the south. On the 85-ft. level, drifts run out 200 ft. easterly and 190 ft. westerly. Ore is being stoped above this level. Drifts on the 220-ft. level are to be started immediately.

The mill of 50 tons rated daily capacity contains a jaw crusher 9 by 14 inches, 10 stamps, and a 4-ft. by 3-ft. ball mill in closed circuit with a Dorr classifier. Riffles are set below the stamps, and plates for amalgamation below the ball mill to recover free gold, which amounts to 40% of the total. Grinding is to 50-mesh. Gold in the sulphides is recovered in three Fagergren flotation cells followed by two Kraut cleaner-cells. The mill was started on Nov. 1, 1936. A 200-hp. Fairbanks Morse diesel engine driving a generator furnishes electric power for all machinery. The 440 cfm. compressor is driven by a 100-hp. motor. The hoist on the shaft is operated by compressed air.

Green Mountain, see Jackson.

Hallsted Group is assessed to Y. H. & Frank Hallsted, Virgilia. It is in Sec. 12, T. 25 N., R. 7 E. and Sec. 7, 18, T. 25 N., R. 8 E. The group is now controlled by Virgilia Mining Corp., which see. References to earlier reports on the Hallsted are contained in the accompanying table of mines.

Imperial Mine comprises the T. C. & O. K. patented claims in Sec. 34, T. 25 N., R. 9 E., which are owned by Vincent E. Bayless, Spokane, Washington, or c/o David J. Heisey, 805 Federal Bank Bldg., Dubuque, Iowa. Ernest V. Grant, of Quincy, has a lease and option, and in 1935 had 16 men at work for a part of the year. A 130-ft. shaft, 4 ft. by 8 ft. was cleaned out and retimbered, and 90 ft. of drifting was done at the 100-ft. level. According to Grant, he made a 300-ton test run from this drift, breaking an 8-ft. width of vein, and the ore ran $9 per ton in gold. The vein strikes N. 17° W. and has a vertical dip. Walls are slate. Grant is now planning to sink the shaft to the 200-ft. level.

The new mill is of 30 tons rated daily capacity, and consists of a crusher, ball mill, Dorr-type classifier, plates for amalgamation, and a Simpson 5-cell, pneumatic type flotation machine.

Indian Valley Mine in Sec. 10, 11, T. 26 N., R. 9 E., one mile south of the town of Greenville, is assessed to J. W. Prentiss, 42 Broadway, New York City, later changed to 40 Wall Street, New York City. It is one of the oldest mines in Plumas County and was described in State Mineralogist's Report X, for 1890. The mine had been very active during a period ten years earlier than that date, having been developed by a tunnel 2000 ft. long and a shaft 700 ft. deep on a pay-shoot.

On June 1, 1934, the mine was reopened by the owner, with whom were associated Phillip J. FitzGerald, 913 Russ Building, San Francisco,

and Harry J. Tamke, 2430 Presidio Drive, San Diego. The entire operation is in charge of Hammon Engineering Company, 351 California Street, San Francisco, with George I. Barnett, mining engineer, of Greenville, in charge of the work. The Union level, which is at an elevation of 4000 ft. above sea level was cleaned out and reopened for a length of 3500 ft. Part of this was badly caved and spiling was required to reopen it. On this level 1200 ft. of new work was done, and at the 2100-ft. point a 400-ft. vertical shaft was sunk on the NE. side of the vein at a distance of 40 ft. from it. At the 300-ft. level a cross-cut was driven over to the vein, and it tapped some of the old workings. On the 400-ft. level another crosscut was driven over, and 300 ft. of drifting was done on the vein. An ore-shoot with widths varying from 6 ft. to 18 ft., but not very long on the strike of the vein, was developed by this work. A winze was then sunk on this shoot to the 500-ft. level, and the ore, averaging six-tenths of an ounce in gold per ton, was mined out and hauled to the mill on the adjoining New York property (which see), which is under the control of the same persons. Water pumped from these lower workings averaged 250 gallons per minute. Prospecting is being continued on the Union level. A total depth of mineralization of 900 ft. has been proved by this work at the bottom of the winze, which is at an elevation 100 ft. lower than the town of Greenville. A new road 4000 ft. long was built from the portal of the Union tunnel to the New York mill.

The Indian Valley vein, which is in metarhyolite, strikes NW. and dips vertically, although there are variations on either side of vertical of 5° to 10°. The ore is quartz containing free gold and a very small percentage of sulphide, pyrite, galena and probably one or two others.

New machinery installed at the Indian Valley mine included an air-compressor of 440 cu. ft. displacement, driven by a 75-hp. motor, Leyner drill sharpener with furnace for heating drills, and electric storage battery locomotive, one and one-half ton, Baldwin-Westinghouse. This is used on the Union level and four tons are hauled to the trip, with a grade of two and one-half per cent favoring the load. The amount of the load is limited by braking capacity. All machinery is electrically driven with power furnished by the Indian Valley Light & Power Company. New buildings include a timber-framing shed with power-saw; blacksmith shop and compressor room combined; change room; store room; and office building.

For references to earlier reports on this mine see the accompanying table of mines.

Indian Valley Mining Co. (Standart, Southern Eureka) is operating the *Standart Mine* in Sec. 11, 12, 14, T. 26 N., R. 9 E., one mile south of Greenville. This mine has been described in several older reports of the State Mineralogist, references to which are given in the accompanying table of mines under the new name. C. L. Hibbard is president of the new company and H. C. Hibbard is secretary, 1210 Western Ave., Seattle, Washington. G. L. Johnson, Greenville, is general superintendent.

A new level has been driven at an elevation 215 ft. lower than Standart's level mentioned in State Mineralogist's Report XXIV. A 785-ft. crosscut was driven through granodiorite to reach the Hibernia

or Indian Valley vein, which is 8 ft. to 10 ft. in width. The Southern Eureka and Indian Valley veins are parallel, and are at a distance of 600 ft. from each other. The Little High Grade Vein crosses them at an angle. During the past year, 600 ft. of drifting has been done on the Indian Valley vein, mostly in a southeasterly direction, only 75 ft. of it being to the northwest. Drifting has been continued on the Little High Grade vein to its intersection with the Southern Eureka vein, and 100 ft. of drifting has been done on the latter. A crosscut at the face exposes a width of 24 ft. of good ore (stated to assay $20 to $25 per ton in gold). According to G. L. Johnson, backs of 600 ft. are available on this ore-shoot to the deepest of the old workings. All three of the veins mentioned are vertical in dip. The ore consists of white quartz and bluish silicified dike material, both containing free gold and pyrite. On the southwest wall of the Southern Eureka vein is a width of several feet of gouge, which is barren. Beyond this is granodiorite. Considerable stoping has been done on the Little High Grade Vein, which is 2 to 3½ ft. wide.

Equipment includes a Sullivan two-stage compressor of 325 cfm. capacity, driven by a 50-hp. electric motor. Ore is treated in a 10-stamp mill of 1000-lb. stamps, by amalgamation and table-concentration. Maximum capacity is 30 tons per day with grinding to 30-mesh. The mine is connected to the mill, which is lower on the mountainside, by a 685-ft. cable tramway with two buckets of 750-lb. capacity each. Twenty loads of this size can be handled per hour. All equipment is electrically driven. Plans call for a new mill of modern design; also a new adit 2500 ft. long to tap the ore-shoot on the Southern Eureka vein at an elevation 315 ft. lower than the present adit.

Jackson & Green Mountain Mines are two adjoining groups in Sec. 13, 14, 23, 24, T. 26 N., R. 9 E., near Crescent Mills. The Jackson comprises the unpatented claims: Lizzie, Injunction, Hudson, Jackson, Monroe, Sunset, Tunnel and Sunrise, held by Samuel Altshuler, 2845 Van Ness Ave., San Francisco, and J. W. Ryan. They have for sale this group and the adjoining Green Mountain of 96 acres, patented, which according to a check of the county assessor's records, made in the spring of 1936, is assessed to Harold Boericke, Primos, Pennsylvania.

Development work has been done from time to time on the Jackson group, and some of it is described in State Mineralogist's Report XXIV, p. 290. Some new work was done in 1934 and 1935, but the property was idle in the summer of 1936, when the Crescent Mills district was visited. A number of quartz veins, which are stated to give good assays in gold are exposed on the property.

The Green Mountain is credited with a production of $1,000,000 to $2,000,000 in the years from 1860 to 1890. The lowest tunnel was 6075 ft. long, and reached to within 600 ft. of the Cherokee shaft. A portion of this tunnel was reopened by *Minesamerica Corp. of Nevada* in 1932–33, but this corporation gave up the property before the entire tunnel was opened.

References to earlier reports on the property are contained in the accompanying table of mines. Altshuler has reports and maps of both properties, copies of some of which he has placed on file at the Redding office of this division.

Jamison Mine, listed in State Mineralogist's Report XXIV as *Plumas Eureka Annex Mining Co.* is now held by *Carnation Gold Mining Co., Ltd.,* Robert Jefferson, president, 29 Broadway, New York City. The property includes 421 acres of patented land, and 460 acres of unpatented mining claims, in Sec. 25, 26, T. 22 N., R. 11 E., at Johnsville, adjoining the Plumas Eureka mine.

The mine was not in operation when visited in the summer of 1936, but a crew of eight or ten men was at work making repairs to the dam at Jamison Lake, one of the high lakes from which water-power is developed for the mine. According to Robert C. Jefferson, who is in charge at Johnsville, a large tonnage of ore of milling grade was developed by a former operator by three years of work. He states that a 100-ton mill will be built. References to older reports on this mine are given in the accompanying table of mines.

King Solomon Mine is a patented property of 41 acres in Sec. 25, T. 25 N., R. 10 E., assessed to Cate Bros. of Quincy, and others. It is 12 miles NE. of Quincy at elevations of 6500 to 7000 ft. The property was idle when visited in September, 1936, but the 60-ft. vertical shaft mentioned in State Mineralogist's Report XIII, had recently been equipped with a small pump, driven by a gasoline engine, and an effort had apparently been made to unwater the shaft. No other new work was noted. Country rock is mapped by Diller as Taylor meta-andesite and by Turner as augite-porphyrite.

La Honda Mine, held by J. W. McKay, is in Sec. 29, T. 24 N., R. 8 E., on Deadwood Creek, a tributary of Spanish Creek. It is equipped with a crusher, two-stamp mill (stamps about 1000 lb. each), plates for amalgamation and a small Wilfley table, all driven by water-power. The property was idle when visited. Apparently some ocher-stained gouge and decomposed country-rock (slate) had recently been mined alongside the portal of an old, caved tunnel, and ore had been trammed in a car to the mill bin nearby.

La Reina de Ora, held by A. W. James and P. H. James, Box 65, Greenville, is in Sec. 35, T. 27 N., R. 8 E. Some prospecting has been done here on small quartz veins in slate, and the property is equipped with a two-stamp mill. It was idle when visited.

Las Plumas Mining Co., see Onion Valley Mine.

Long Valley Mine (Stauffer) is in Sec. 6, T. 26 N., R. 9 E., six and a half miles from Greenville by mountain road. In three years of operation starting in 1902, the mine is said to have produced $100,000 from a 250-ft. inclined shaft, the ore-shoot being 250 ft. long, and composed of clay-like material.

Four claims are now held by Connie Baker, L. J. Develter, and John Holly of Greenville, and Dr. I. L. Tucker of Oroville. They expect to mine, with an open pit to a depth of 85 ft. below the surface, a deposit consisting of quartz stringers in slate carrying gold. An old, caved tunnel which taps the deposit at that depth provides drainage.

They have on the property milling machinery consisting of a ball mill, 5 ft. in diameter by 4 ft. long, plates for amalgamation, and a 42-hp. oil engine. They expect to add a crusher and classifier. Three men are at work.

The same men have a group of 12 claims on Rush Creek, Sec. 25 (?) T. 26 N., R. 8 E. A width of 50 ft. of low grade gold ore is said to occur on this group.

Lucky S Mine is an old mine in Sec. 28, T. 27 N., R. 11 E., ten miles northeast of Taylorsville by steep mountain road, and at an elevation of 6500 ft. It was being worked with a five-stamp mill in the years from 1890 to 1896 according to accounts in State Mineralogist's Reports X and XIII. The mill had a capacity of 8 tons per day, and the treatment was amalgamation followed by concentration of the sulphides.

Recently the property has been developed by *Ora Plata Mining Corp.* with a crew of six men. R. O. Fife, 8707 Santa Monica Boulevard, Los Angeles, was in charge. New buildings to house the men were constructed; also an assay office; and a 200-ft. shaft was sunk. Drifting on the 100-ft. level amounted to 400 ft., and on the 200-ft. level to 100 ft.

The property was idle when visited in November, 1936, but a few tons of ore from this new work were seen on the dump. The ore had apparently been sorted, and consisted of quartz with roughly 50% sulphides, mostly pyrite, with some chalcopyrite, sphalerite, and galena. This is said to carry considerable gold and to have come from a vein six inches in width.

Mary Ann Mine is in Sec. 32, T. 22 N., R. 8 E., on Browns Hill near Cascade, and contains 40 acres, formerly part of the George McMillian homestead, now owned by R. H. Vermillion of Feather Falls or 1001 E. Slauson Ave., Los Angeles. An adjoining 40-acre tract in Sec. 29 is owned byA. E. Rogers, who is said to be associated with Vermillion. The Browns Hill Mines of A. P. Linville adjoin. The mine is reached by means of a rough mountain road, 18 miles long, from La Porte; also from the west by a similar road connecting with a paved road from Oroville.

An upper tunnel 300 ft. long follows a quartz vein striking N. 30° E. and dipping 47° NW. A shaft 142 ft. deep on the vein connects this tunnel with a lower one 700 ft. long, of which 300 ft. to the north and 75 ft. to the south is drifting on the vein. The width of quartz varies from 1 ft. to 12 ft. The quartz contains free gold and a small percentage of pyrite. Country rock is amphibolite.

The mill has recently burned. It was of 25 tons rated daily capacity and contained primary and secondary crushers, Hardinge ball mill, Dorr type classifier, plates for amalgamation and six small Kraut flotation cells. Gasoline engines were used for power.

McCray Ridge Placer Mining Co. is in Sec. 33 (?), T. 22 N., R. 11 E. The property of 600 acres of unpatented mining claims is held by E. C. Kelsey, Quincy, five-eighths, and Edward Petry, Johnsville, three-eighths. The property was idle in September, 1936, but according to Kelsey, a company named as above has recently driven 1000 ft. of tunnel. He estimates that 500 ft. more of work on an incline sloping downward will be needed to reach the gravel. This property is near the Johnsville-Gibsonville road, at a point four and a half miles from Johnsville.

Mel-Dick Mine (Newtown) is a drift placer in Sec. 3, T. 24 N., R. 9 E., owned by H. L. Cate and S. M. Leavitt, Quincy. The property of 101 acres is leased and optioned to J. E. Dick of Los Angeles, and Melvin E. Jepson, Reno, Nev. A 400-ft. tunnel has been driven in slate bedrock and two raises, one 10 ft. high, the other 20 ft. high, have been made to the gravel, which is stated to be of very good grade. The property is said to contain 4500 ft. of virgin ground on the Elizabethtown channel, on which both hydraulic and drift mines have been operated. The Bushman is nearby. Two men are working.

Mosquito Creek, see Mystery Gulch.

Mystery Gulch Mine is a single unpatented quartz claim in the unsurveyed Sec. 20, T. 26 N., R. 7 E., on McFarlan Ravine, a tributary of Mosquito Creek. It is reached by 2½ miles of steep mountain trail from the Longville-Belden road. Charles M. Pense of Belden is the

New York mill near Greenville.

owner. He states that John J. Raskob has taken an option on the mine.

A 100-ft. tunnel runs northwesterly following the footwall of a 105-ft. diorite dike in slate. The dip is 45° NE. This rock is light in color but considerably stained by limonite. The grain size is about one millimeter. It consists largely of feldspars and bleached mica which was probably originally biotite. No primary quartz was seen. Seams of quartz a fraction of an inch wide crisscross through this dike and the gold is associated with these. Several thousand dollars have recently been recovered from small bunches of this material. Over $400 is said to have been recovered from a single pan. At a point 50 ft. lower a 50-ft. tunnel has been driven on the same contact and small amounts of gold were recovered near the portal. At a point several hundred feet lower and near the creek level in McFarlan gulch, a new tunnel has recently been started. There is more quartz here

and the ore is said to be more uniform but lower in grade, which is stated to be $4 to $5 a ton. A five-eighths-inch cable connects this lower tunnel with the mill. The single bucket is pulled back by a hoist driven by a gasoline engine. The mill includes two stamps of 1000 lbs. each, amalgamating plates and Wilfley table, driven by a gasoline engine.

New York Mine includes 70 acres of patented mining claims in Sec. 10, T. 26 N., R. 9 E., assessed to *Plumas Gold Mining Company,* c/o Walter H. Parsons, Greenville. It is optioned to John W. Prentiss and associates, who are also operating the Indian Valley Mine (which see). Hammon Engineering Company, 351 California St., San Francisco, is in charge of the work. George I. Barnett, mining engineer, of Greenville, is in charge of operations at the mine.

Development at the New York mine consists of about 10,000 ft. of workings on five different tunnel levels. At the time of visit, the lowest level, at the same elevation as the top of the mill, was being sampled, and production of ore from it was being planned. The mill described in State Mineralogist's Report XXIV, 1928, has been thoroughly modernized by the present operators, at a cost of $19,000.

The crusher, ore bins, building, and other small items of equipment from the old mill were utilized, thus saving roughly half the cost of a new mill. Machinery added included a Hendy ball mill of the rapid-discharge type, hydraulic jigs or gold traps, corduroy blanket tables, and a six-cell flotation machine with settler and filter for the concentrate. The arrangement of these is shown on the accompanying flow sheet.

This mill was designed to treat ore from both the Indian Valley mine and the New York mine. When visited it was operating 24 hours per day on ore from the Indian Valley mine only. The operation is interesting because a rather typical Californian gold ore is being treated with a recovery of 95 per cent, sometimes more, of the total gold contained in the ore. The ore, however, is of a type containing a very high percentage of hard quartz and a very low percentage of metallic sulphides, with free gold. Attention is called to the combination of hydraulic jigs or gold traps and corduroy blanket table. These make an excellent substitute for amalgamation on plates and are less troublesome to maintain. By means of them 70% of the gold is recovered in a free form, amalgamated in the barrel, and sold directly to the mint; thus smelter charges on the bulk of the gold are avoided. The percentage of the recovery divided between the traps and the corduroy tables is quite variable, and it is felt by the operators that both are essential to give the high recovery that is being obtained. The tables are arranged so that the flow of pulp can be fed to two runs of corduroy while the third is being cleaned. The pulsation in the jigs is caused entirely by turning on and shutting off a valve in the water line, which extends a short distance into each hopper. No mechanical plungers are used in the jigs, but the pulsating valve (Richards) is mechanically driven at the rate of 80 pulsations per minute. The concentrating table below the flotation machines recovers mostly steel worn from the ball mill, but this contains enough gold to pay for the operation of the machine; and the additional advantage of protection against possible faulty action of the flotation is obtained.

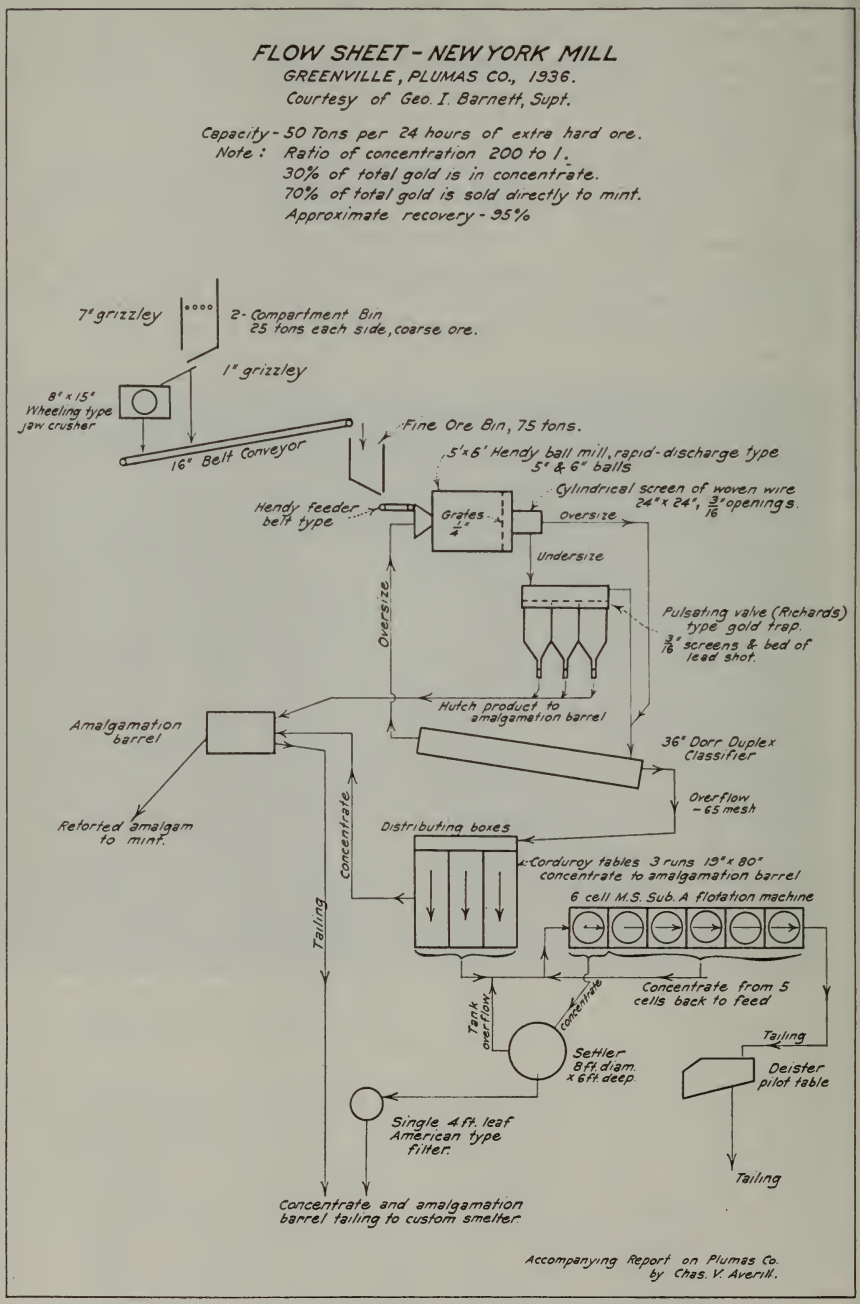


FIG. 2. Flow sheet of New York mill.

On account of the extreme hardness of the ore and the absence of a secondary crusher, which may be provided later, the steel wear in the ball mill has been excessive, new liners being required after three months of operation. The mill has not operated long enough to give very accurate figures on cost of milling per ton, but roughly it is $1.50 for operating cost, including labor, power, and repairs, and including $0.30 per ton for steel wear.

For references to earlier reports on this mine, see accompanying table of mines.

Onion Valley Mine (Mayflower?) is an old drift placer in Sec. 5, 6, T. 22 N., R. 10 E., in Onion Valley near the Nelson Point road from Quincy to La Porte. *Las Plumas Mining Co.* has recently reopened an 1800-ft. tunnel, and has driven it ahead 580 feet to the north. A raise was driven 60 ft. to the gravel. When visited in August, 1936, the mine was idle. Gertrude Herndon, 1963 Benicia Ave., Los Angeles, is president, and Louis Barnes, 408 Citizens National Bank Building, Los Angeles, is vice president.

Ora Plata Mining Corp., see Lucky S.

Peerless Development Co., see Gold Stripes.

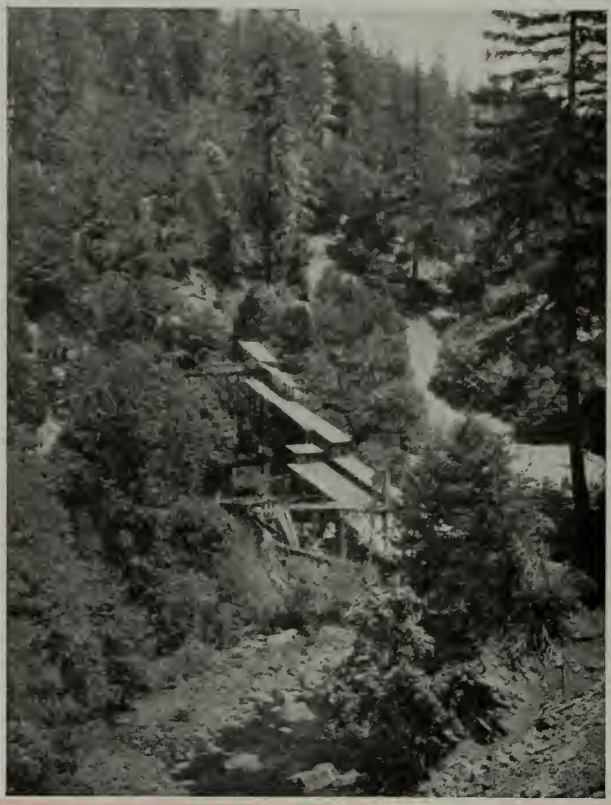
Peter Mine is in Sec. 7, T. 26 N., R. 11 E. Gold was produced here as early as 1867, from oxidized ores overlying copper ore that has been described in Bull. 50 of this division. It is owned by Arthur Peter of Taylorsville. About a year's work was done in 1934. Some of the old workings were cleaned out, and a few hundred dollars in gold was recovered from ore found in them. No new development work was done. The mine was idle when visited in 1936.

Pine Leaf Mining Co. has been operating a drift placer in Sec. 35, T. 25 N., R. 8 E., nine miles by road northwest of Quincy. Henry Reimers, Rosemead, California, is president, and Orman Lutz, 5400 Hillen Drive, Oakland, is secretary. At time of visit, Harvey S. Bennett of Quincy was in charge at the mine. The property comprises 50 acres, patented, and leases on adjoining timber-lands. The deposit is an old river-channel of auriferous gravel capped by volcanic material. It has been worked on a small scale for many years.

Of the 800-ft. bedrock tunnel in the slate, Bennett has recently driven 315 ft., then raised 35 ft. to the gravel, and drifted a total of 450 ft. in various directions in the gravel to prospect it. He has the miners take two 60-lb. samples per day from this work, which he washes in a rocker. He makes the resulting gold up into a button and weighs it. All of his figures are based on the old price of gold ($20.67). A suitable percentage should be added to the figures below to allow for the present price of gold ($35). He states that an average of the last ten samples has indicated a value for the gravel of $2.24 per cubic yard in place, and the 10 samples before that, $1.50 per cubic yard in place. Some of the previous sampling in other parts of the development work has shown gold values too low for mining by the drift method. The mine can be worked the year round providing suitable preparations are made for snow. Snowfall during the winter 1934-1935 was unusually great, and eight and a half feet lay on the ground at one time.

Mine-water is collected in a 200,000-gallon reservoir at the portal of the adit. Beyond this is a bin holding 35 mine cars of gravel ($\frac{1}{2}$-yd. cars). A 350-ft. sluice, 12 by 12-inch cross section, runs beneath the bin and the tailing-dump. This is equipped with steel and cast-iron riffles throughout. Bennett estimates that eight cubic yards of water are required to wash one cubic yard of gravel. Grade of sluice is 1 in 12 or 12 inches per 12-ft. box.

Plumas Eureka Mine in Sec. 2, 11, 12, 13, 14, 22, 23, 26, T. 22 N., R. 11 E., at Johnsville, was a producer for many years, starting in 1851. C. D. Stark, who was in charge of the property for 25 years, estimates



Plumas Eureka mill with dump of Mohawk tunnel above and to left.

that 1,000,000 tons of ore were produced, which yielded $8 per ton in gold by amalgamation. No record of the earliest production is available. Stark's last period of operation was in the years from 1916 to 1925, and at that time the mill was operated for testing purposes only. He states that 40,000 tons of ore were developed on the Mohawk flat vein, which would yield $7.73 per ton by amalgamation on plates and $1 per ton in auriferous galena and pyrite, with gold at $20.67 per ounce. Practically all of the workings are now inaccessible on account of caving. The old operations have been described in half a dozen reports

of the State Mineralogist, references to which are given in the accompanying table of mines.

The property is assessed to Plumas Eureka Corporation, Phillips Trustees, Room 911, No. 1 Federal Street, Boston, Mass. The operating company is called *Plumas Eureka Mines, Inc.;* H. O. Harrison, president, 1625 Van Ness Avenue, San Francisco; H. W. Weber, vice-president and engineer in charge, Johnsville, Plumas County, California; George A. Huston, treasurer. H. W. Weber and A. W. Mostleotto have just secured a lease from the operating company on the portion of this property above the Mohawk tunnel, which is next above the tunnel at mill-level, called Eureka. At the time of visit, on August 18th, 1936, they had just started a 20-stamp mill. The building has been repaired and the stamps have been reset on concrete foundations. Ore bins with a capacity of 850 tons are available. English corduroy tables 22 ft. long by 52 inches wide have been installed. There is a separate table of this size for each battery of five stamps. The 30-mesh product of the stamps flows over the English corduroy, then to a three-cell, 24-inch impulse jig, mechanically driven. The hutch product from the jigs is drawn off continuously and is concentrated on a Wilfley table. An extraction of 79 to 86% is claimed, with the concentrate assaying $176.00 per ton. The stamps in this mill are driven by a 48-inch Pelton wheel. An 18-inch Pelton wheel drives the amalgation barrel, and a 25-kw. generator is driven by a 24-inch Pelton wheel. Water is obtained from Jamison Creek through three and a half miles of ditch with a head of 370 ft. The jaw crusher, the jigs and the concentrating table are driven by electric motors.

Work has been started on a lower power house, where a 550-kw. generator has been set on a concrete foundation. Plans call for the installation of 1185 ft. of 24-inch wood-stave pipe in two separate lines to drive Pelton wheels attached to this generator. Eight cubic feet per second of water are available from Jamison Creek, through one and one-half miles of ditch under a head of 92 ft.

Ore for the mill was coming from the apex of the main vein 1800 ft. higher in elevation than the mill and was being trucked to the mill at the rate of 40 tons per day. Ore was taken from a second vein in the same location one to six feet wide, striking at a small angle in the foot-wall of the main vein. Both veins have steep dips. The main vein is roughly 20 ft. wide. A few feet of this was mined in the early days on the foot-wall side but the balance of some 15 ft. remains and it is said to assay $6.00 per ton in gold at the present price.

Some power-shovel mining was done about a year ago on material eroded from these veins about half way down the mountain side from the apex of the veins to the mill. The erosion that produced this deposit is thought to have been partly glacial. A recovery of 71¢ per cu. yd. is said to have been made with a large loss in the tailing. A plan is being considered to hydraulic this deposit and mill the tailing. If this is done, Eureka Lake will be raised 30 ft. with a dam; and a tunnel, which has already been started, will be continued to tap the lake. With the dam raised an additional 30 ft., the lake will cover 64 acres to an average depth of 44 ft. At time of visit 17 men were at work.

Plumas National, see Drader.

Plumas Quartz Mine (Carter-Blood property) is a single patented claim in Sec. 32, 33, T. 26 N., R. 10 E., three miles from Crescent Mills on the Taylorsville road. It is assessed to Kenneth Murray, Greenville. *Columbia Development Co.* is operating the property, with E. R. Zeigerst of Crescent Mills in charge.

The deposit is a quartz stringer zone apparently mostly in diorite, but slate shows on the hanging wall in one place on the 65-ft. level. The strike is S. 73° E., and the dip is 85° S. Zeigerst has recently reopened a 140-ft. adit level and has done 64 ft. of new drifting and run crosscuts of 8 ft. and 25 ft. A 22-ft. width of vein matter exposed in the longer crosscut is stated to assay $12 per ton in gold. He has also cleaned out and partly retimbered a 65-ft. shaft. On the 65-ft. level, 173 ft. of old work has been cleaned out and 148 ft. of new drifting has been done; also several short crosscuts of a few feet each have been driven. A raise has been driven to connect the two levels at a point 225 ft. from the shaft. Power for pumping and hoisting is furnished by gasoline engines. Drilling is done by hand.

Powell Group of two claims in Sec. 1, T. 26 N., R. 8 E., is held by M. M. Powell of Greenville. He is prospecting them at a location half a mile south of the Gold Stripes (Melville's). Quartz stringers in slate are exposed by surface-cuts on the opposite side of the serpentine dike from the Gold Stripes. Powell is now driving a 75-ft. adit level to get 100 ft. of backs beneath one of his cuts. An additional distance of 21 ft. must be driven to strike the quartz, which is said to give good assays in gold at the surface.

Premium Mine in Sec. 32, 33, T. 26 N., R. 10 E., a mile and a half southwest of Taylorsville, was idle when visited in June, 1936. The portal of the main adit had caved, and the five-stamp mill, which had been operated during part of 1935, was being dismantled and hauled away.

According to a report by Gilbert H. Goodhue, mining engineer, of Live Oak, California, a copy of which is on file at the Redding office of this division, four veins occur on the property. He states that the Premium vein produced $180,000 in gold. The date of this production was about 1870. Goodhue and associates had a lease on the property in 1905, unwatered a 60-ft. winze, 360 ft. from the portal of the Premium tunnel, and found the vein to be 2 ft. to 5 ft. in width, averaging $5.90 per ton in gold. At 160 ft. in the tunnel, a 24-ft. winze was sunk in 1909, and a drift run south for a short distance. This work exposed 14 inches of ore assaying $6 to $20. He states that an underhand stope 100 ft. from the portal yielded $816 from 100 tons in 1882. A lower tunnel, 240 ft. above the level of Indian Valley, or 305 ft. below the old workings, intended to cut the first ore-shoot developed by the Premium tunnel, was started in 1906. According to the best information available, this tunnel has not yet reached the objective mentioned. Other veins should be cut beyond the Premium vein.

Rainbow Mine comprising two claims in Sec. 25, T. 22 N., R. 7 E., near Browns Hill and Cascade, is held by A. L. Allen of Feather Falls. A quartz vein striking east and west and dipping 68° S. has been developed with a 43-ft. incline shaft. The width averages two feet but there are swells to seven feet. At a point 57 ft. lower in elevation than

the collar of the shaft, Allen is driving a 190-ft. adit to connect with the shaft. He estimates only a few feet additional driving will be needed. The adit is in the formation mapped by Turner on the Bidwell Bar sheet as amphibolite. Most of it is a green schistose rock but here it contains a few dark and a few almost white strata. The white quartz of the vein contains free gold, a small percentage of pyrite, chalcopyrite, and possibly a little galena and sphalerite.

Ready Bullion Mining Co. of Sacramento built a mill on a property in Sec. 18, T. 21 N., R. 12 E., near the Plumas-Sierra county line, at a cost said to be $100,000. Gold Lake is within a mile of the property, but is across the line in Sierra County. A quartz vein is developed by a 400-ft. incline shaft that extends beneath Round Lake. The mill burned to the ground shortly after it was completed in 1935, and the timbers in the shaft burned also. The property was idle when visited, but a few men were planning to spend the winter in prospecting a vein in a different location from the one mentioned above.

Reising Mine is a patented claim, Mineral Survey 5038, in Sec. 9, T. 25 N., R. 8 E., four miles north of Virgilia. It is assessed to H. C. Flournoy, Quincy, and others. The deposit is said to consist of two large lodes, an upper lode 123 ft. wide and a lower lode 157 ft. wide, with 150 ft. of country rock between. The owner has sample returns indicating a gold value of about $1.25 per ton across the entire widths of these lodes, with gold at $20.67 per ounce. Better assays have been obtained from selected spots. These are contained in a report on the property by J. A. Edman. A considerable production of placer gold has been made here.

Riodel Group, in Sec. 1, T. 26 N., R. 8 E., and Sec. 35, T. 27 N., R. 8 E., near the Gold Stripes, is a group of seven claims held by W. J. Jordan and Joseph Bigler, both of Greenville. Some of the claims were formerly called *White Hope.* Prospecting is being done by means of surface cuts, of which the deepest at time of visit was 20 ft. in depth. These expose quartz stringer-zones in slate. Recent work has been on a lease held by Jordan alone, being the N½ SW¼ Sec. 36, T. 27 N., R. 8 E. This is leased from the Red River Lumber Co.

Robinson Mine, see Granite Basin Mining Co.

Saw Pit Mine is a patented property of 78 acres in Sec. 6, 8, T. 22 N., R. 10 E., in Onion Valley, assessed to A. W. Dozier, 529 31st St., Oakland, and E. P. Turner. In 1934, it was being operated by Ed. D. Westbrook, who had a three-stamp mill of 1250-lb. stamps in operation. He was treating 15 tons of ore per 24 hours by amalgamation and table-concentration. Power was furnished by gasoline engines.

According to Westbrook, the property is developed by a 140-ft. shaft with levels at 35 ft., 50 ft., 75 ft., and 130 ft. The 75-ft. level comprises drifts of 40 ft. to the north and 160 ft. to the south. On the 130-ft. level is a drift 90 ft. long. This work is said to develop a 3½-ft. vein in slate, with a steep dip, and a pay-shoot 225 ft. long of $15 ore with gold at $35 per ounce. The mine has not been visited.

Shaffer Gold Mining Co. (White Lily, Del Monte, *Seneca Consolidated Mining Co.*) holds a group of patented claims in Sec. 9, 10, 11,

14, 15, 16, T. 26 N., R. 8 E., at Seneca. They are covered by Mineral Surveys 4824, 5218, 5223 and 5382, and are assessed to C. B. Shaffer, 33 S. Clark St., Chicago, Illinois. Considerable work has been done here since the location of the property in 1896, and some production has resulted. An old adit, 5190 ft. in length, which developed a vein said to be 50 ft. to 60 ft. wide, has caved. Fuller descriptions of this old

Mill of Shaffer Gold Mining Co. at Seneca.

work are contained in State Mineralogist's Reports listed in the accompanying table of mines.

A new 1000-ft. adit running easterly has been driven at an elevation 65 ft. higher than the old White Lily adit; also a 65-ft. raise to connect the two. This work develops a flat-lying body of crushed quartz ore. Apparently all of this work has been done in material that has been sliding down the steep slope of the canyon of North Fork Feather River. Some swelling ground was encountered near the face of the adit. The property is equipped with a 10-stamp mill driven by two 6-ft. Pelton wheels. A short run was made in this in February, 1936, but the mine was idle at time of visit. Treatment is by amalgamation. Keith Miller is superintendent.

Sierra Nevada Mining Corp., see Bunker Hill.

Standart Mine, see Indian Valley Mining Co.

T. C. & O. K., see Imperial.

Underwood & Martin. T. Underwood, J. Underwood, and P. H. Martin are prospecting a placer property of 120 acres in the southwest part of Sec. 7, T. 24 N., R. 12 E., near the copper mine of Walker Mining Co.

Virgilia Mining Corporation, Virgilia, Plumas Co., California, or 181 South Park, San Francisco, is operating a group of some twenty claims including the Ohio Point (Duncan) and Hallsted. The Ohio Point is in Sec. 17, 18, T. 25 N., R. 8 E., at the confluence of Rush Creek and East Branch of North Fork Feather River. This is at the southeast end of the group, which extends northwesterly for about two miles.

The new Feather River highway passes close to the shaft and to the portal of the Brooks adit.

For many years the existence of a large body of low-grade quartz ore carrying gold has been known here, and various persons have driven half a dozen adits on it varying in length from 1500 ft. to 2000 ft., at different elevations. From a tunnel near river-level, maximum backs of 1600 ft. to 1700 ft. are available. The lode is a silicified, fine-grained dike, probably dioritic or andesitic, intruded into a black slate-belt of the Cedar formation (Juratrias), striking northwesterly. Half a mile to the southwest is a broad belt of serpentine. The lode strikes N. 40° W., and dips 70° NE. Portions of it are entirely replaced by white quartz. The gold occurs both free and in pyrite. A similar, parallel dike is known to be present on the property.

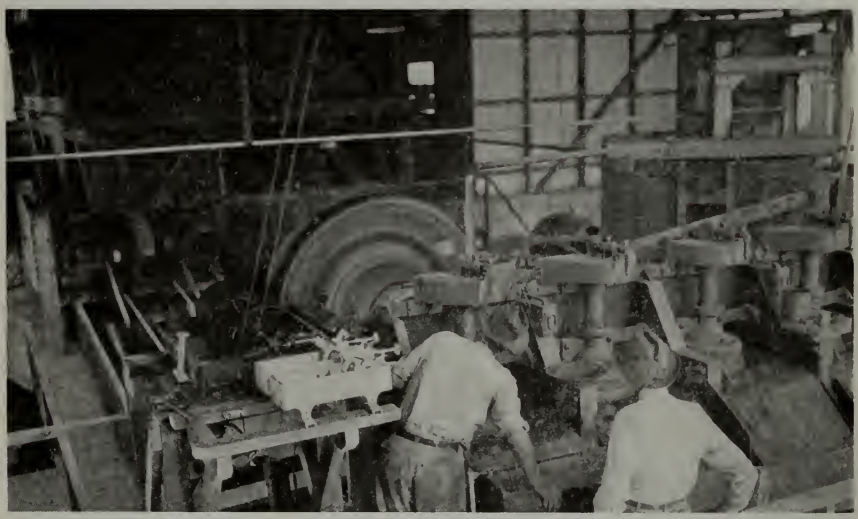
Recent development work includes a 300-ft. vertical shaft near the confluence of Rush Creek and East Branch of North Fork Feather River on the Ohio Point claim. The shaft has two hoisting compartments and a manway, and levels at 100-ft. and 200-ft. depths. Roughly 700 ft. of drifting has been done both to the northwest and to the southeast on each of the levels. Crosscuts have been run each 50 ft. from the southeast drift on the 200-level, and at intervals of 100 ft. in the other drifts. These workings develop a lode from 35 ft. to 100 ft. in width. However, the best ore has been found on the footwall in width varying from a few feet to 30 ft., and it is planned to mine this ore with shrinkage stopes for an average width of 15 ft., and to treat the ore in the new

New headframe and hoist house of Virgilia Mining Corp.

flotation mill. The next level on which lateral work will be done is the 400-ft. level. Diamond drilling has established the fact that the lode exists beyond present development faces. At a distance of 2400 ft. northwest of the shaft, a new adit-level called the Brooks tunnel has been driven. It is several hundred feet long, mostly in slate, and exposes the lode. Mine equipment includes a new double-drum hoist

and air-compressors electrically driven. Pumps handle 500 gallons of water per minute.

The new mill, which was started August 18, 1936, contains a 28-inch Traylor TY crusher to reduce ore to half-inch size, a 7-ft. by 3-ft. Hardinge ball mill driven by a 100-hp. motor, Dorr classifier, Kraut hydraulic jig. Kraut flotation cells and an American filter with two 4-ft. leaves. It is expected to treat 140 tons of ore per day, grinding to 60-mesh. An inclined tramway with a skip running on rails, which dumps automatically, connects ore-bins at the shaft with those at the mill. C. H. Potter is general superintendent at Virgilia.



Interior of new flotation mill of Virgilia Mining Corp.

White Hope, see Riodel.

Zola Group comprises seven claims, both quartz and placer, in Sec. 10, 11, T. 24 N., R. 9 E., held by Carl G. Hankel of Quincy and Harvey S. Bennett. They are on both sides of the paved road from Quincy to Keddie, at a point two and a half miles from Quincy. Bennett has recently sunk a 25-ft. winze on a narrow quartz vein from the face of an old 180-ft. drift-adit. In another location he has sunk a 30-ft. shaft from the surface on a similar vein. This is associated with a soft decomposed (sand-like) dike heavily stained by iron oxides. Walls of this intrusion are slate. The quartz is said to give assays in gold. The Bell and Iowa patented claims of David J. Heisey adjoin to the northwest.

Mill of Engels Copper Mining Company.

TABLE OF MINES AND PROSPECTS, PLUMAS COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST

Name	Sec.	Twp.[1]	Range	Kind of mine[2]	Remarks[3] (Location or ownership)	Elevation, feet	Area, acres	References to reports of State Mineralogist[4]
Alhambra	15	22	8	Q	M. McIntosh, Quincy*	5,500	40	XVI, p. 94
Altoona	23	26	9	Q	W. S. Firmstone, Greenville*	5,000	17	XVI, p. 95; XIII, p. 287; XII, p. 213; X, p. 472
Antelope	28	22	13	Q	C. M. Johnson, Mohawk	4,700	160	XVI, p. 95
Antlered Crest Co.	31 11 6	22 21 21	9 8 9	P	c/o R. E. Sanborn, Calif. Packing Corp., 101 California St., San Francisco	5,000	280	XVI, p. 64
Apex & Pensotti	29 or 32	23	10	Q	C. M. Root & P. Pensotti, 428 Broderick St., San Francisco	6,000	-------	XVII, p. 455
Arcadian	10, 15	26	9	Q	L. P. McIntyre and others, Greenville	3,900	100	XXIV, p. 285; XVI, p. 96; XIII, p. 305
Australia	1, 12	24	8	P	Australian Placer Min. Co., c/o J. D. Hyland, Box 77, South San Francisco*	3,800	110	XVII, p. 455; XVI, p. 65
Austrian	24	25	11	Q	Austrian Syndicate Min. & Devel. Co., c/o A. B. Hill, Jr., 14 Montgomery St., San Francisco*	5,500	100	XXIV, p. 285; XVI, p. 97
Barker Hill	8	26	8	P	Hammond Bros., Seneca	4,600	-------	XXIV, p. 298; XVI, p. 65
Barnes	-------	------	------	C	Harry Barnes, Engelmine	-------	360	XXIV, p. 270
Beardsley	14, 15	26	11	C	L. B. Longnecker, trustee, c/o A. L. Beardsley, 827 Roosevelt Bldg., Los Angeles	6,000	320	See Iron Dike also XXIV, p. 270; XVII, p. 462; XIII, p. 308
Beckwith Con.	20, 29	22	11	P	Beckwith Consolidated Min. Company	6,500	480	XVI, p. 65; XIII, p. 288; XII, p. 213
Beetle	25	27	10	Q	A. D. McMillan, W. P. Boyden, Greenville	4,000	40	XVI, p. 98
Belden	-------	25	7	P	Robert Belden, Belden	-------	-------	XXIV, p. 298
Bellevue	26	22	9	P	Bellevue Mining Co., 707 Mills Bldg., San Francisco*	4,800	2,000	XXIV, p. 298; XVI, p. 66, 67
Bell, Iowa Leavitt Ext.	2	24	9	Q	David J. Heisey, D.D.S., 805 Federal Bank Bldg., Dubuque, Iowa	3,500	60	XVI, p. 98; XIII, p. 292; X, p. 478
Bessie (Murdock or Mendota Hill)	1	24	8	P	See Australia above. Australia Placer Min. Co.	3,800	80	XVI, p. 67
Big Cliff	25	26	11	C	Genesee Con. Mines Co., 827 Roosevelt Bldg., Los Angeles	5,000	160	See Iron Dike also XXIV, p. 270; XVI, p. 99
Bigelow	32	23	11	Q	John F. Bigelow, San Francisco	6,000	20	XVI, p. 99
Black Bart	30	23	7	Q	Joseph Peppin, Brush Creek	4,800	20	XVI, p. 100; XIII, p. 293
Black Hawk	27, 34	25	9	P	U. S. Webb, 640 State Bldg., San Francisco*	3,500		See Granite Basin in text this report
Black Oak	-------	------	------	Q	Six mi. W. Quincy, see White Oak also	3,400	40	XIII, p. 288
Blind Lead	-------	------	------	Q	Six mi. S.W. Greenville	-------	-------	X, p. 475
Blue Bell	2	25	11	Q	Blue Bell Mining Company	4,200	-------	XVI, p. 100; Bull. 50, p. 180
Blue Gravel	21, 22	21	8	P	W. H. Spencer, Gibsonville, et al., see Rio Vista also	5,000	230	XVI, p. 67
Bonanza & Bobtail	20	27	11	C	S. P. Jacks & G. M. Cooksie	5,000	40	XVII, p. 463
Bonnie	3	22	10	P	W. C. Moran, 63d and Adeline, Berkeley*	6,500	161	XVI, p. 173
Boyd	10	23	7	Q	O. G. Boyd, Bucks Ranch, A. G. Boyd, 1235 Powell St., San Francisco	5,500	80	XVI, p. 101

Braito	26	26	9	M	Fred E. Braito & T. J. Mason, Crescent Mills	4,000		XVI, p. 179
Broken Back	(?) 3	22	7	Q	W. H. Duncan, Bucks, via Meadow Valley			XXIV, p. 285
Brown Bear					See Carr			
Brown Bear	1	21	12	P	H. H. Evans, Clio*	5,300	120	XVI, p. 89
Browns Hill	29, 30	22	8	Q	A. P. Linville, 1701 Allston Way, Berkeley	5,000	160	See text this report
Buckhorn	7, 18	23	11	P	J. W. Fricke, c/o G. F. Weber Co., 601 Mission St. San Francisco	4,000		XXIV, p. 299
Bull	25	24	9	P	Mrs. Reed, Berkeley	4,500		XVI, p. 68
Bullion	14	26	11	Q	A. L. Beardsley, Genesee	5,300	140	XVI, p. 101
Bullion	29	22	13	Q	Mrs. A. E. Hayden, Reno, Nevada	5,000		XVI, p. 101
Bull of the Woods				C				XXIV, p. 270
Bunker Hill	15, 16	22	10	P	c/o J. T. Buel, La Porte	6,500		XVI, p. 68. See text this report
Burch & Woody	21, 28	26	9	M		5,000		XVI, p. 179
Bushman	34	25	9	P	L. L. Clough, Quincy*	3,700	58	XVI, p. 68; XIII, p. 288; XII, p. 214; XI, p. 328
Buster	24	25	10	Q	Sol. Camp, Downieville, et al.	7,000	160	XVI, p. 102
Butte & Iron Lily	1	27	10	Q	Mrs. J. D. Williams, 617 Lincoln St., Oroville	6,000	800	XVI, p. 102
Butte Bar	35	23	8	Q	Deeded to State, 1932	3,000	40	XVI, p. 102
Butterfield & Paddock	19	24	11	Q	F. L. Butterfield & A. H. Paddock, Spring Garden	4,000	40	XXIV, p. 285
Butterfly	27	25	9	Q & P	C. E. Smith, Quincy, et al.	3,700	272	XVI, p. 103; XIII, p. 288; XII, p. 214. See text this report
Cahalan				Q	1½ mi. N.W. Crescent Mills	3,900	20	XIII, p. 289; X, p. 472
Caldwell	26	23	6	Q	G. M. Sparks, 1598 Hayes St., San Francisco*	4,600	20	XVI, p. 104
California	33	26	10	Q	H. S. Hersman, Gilroy*	4,600	82	XVI, p. 105; XIII, p. 289
California Goldfields	6	26	9	P	California Goldfields Development Co., Gridley	5,000		See text this report
Calnan	11, 14	25	11	C	M. J. Calnan, Genesee	4,300	160	XVII, p. 463
Cameron	16	26	8	P	A. N. Cameron, Seneca	3,300	380	XXIV, p. 299; XVI, p. 69, 88; XIII, p. 289
Cameron				Q	R. M. Cameron, Seneca			XVII, p. 456
Canton	1, etc.	24	6	P	Canton Placer Mining Co., c/o Mrs. C. C. Coffin, 1990 Marin Ave., Berkeley*	2,000	623	See text this report
Carnation, (Little Jamison, Plumas-Eureka Annex)	25, 26	22	11	Q	Carnation Gold Mining Co., Johnsville*	5,400	420	XXIV, p. 293; XVI, p. 136; XIII, p. 298; XII, p. 217; XI, p. 330; X, p. 483; VIII, p. 481. See Jamison in text this report
Carr	11	24	11	P	Brown Bear Mining Co., c/o Lawrence Carr, Santa Cruz	6,000		XVI, p. 69
Cascade	11, 14	24	11	P	Mrs. Mary Turner, Vallejo	6,000	800	XVI, p. 90; XIII, p. 290
Cash Entry	23, 26	25	5	P	Cash Entry Mining Co., c/o Ed. Harkness, Chico*	5,000	293	XVI, p. 69
Castle Rock	10, 11	23	10	P	Wm. Black & J. B. Somers, 2726 Maxwell Ave., Oakland*	4,800	140	XVI, p. 90
Cayot	18	21	8	Q	Frank Cayot, La Porte	4,800	80	XVI, p. 105; XIII, p. 290; XII, p. 214
Channel Peak	13, 14	24	7	P	Channel Peak Min. Co., 518 Grant Bldg., Los Angeles	7,000	820	XVI, p. 69
Cherokee	14, 23	26	9	Q	Mrs. U. S. Webb, Sacramento	4,800	80	XVI, p. 106. See text this report

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Name	Sec.	Twp.[1]	Range	Kind of mine[2]	Remarks[3] (Location or ownership)	Elevation, feet	Area, acres	References to reports of State Mineralogist[4]
Chicken Flat	33	24	8	Q	P. Hansen, Meadow Valley	4,450	20	XVI, p. 106
Chico Star	9	26	8	Q	Mrs. C. Lazarvitch, Seneca	3,300	40	XVI, p. 107; XIII p. 290
Clara	(?) 5	22	7	Q	Ernest Leske, Herman Leske	5,000	20	XVI, p. 107
Cleveland	3	22	11	P	L. Soburo, Johnsville	6,000	120	XVI, p. 90
Columbia Development Co.					See Plumas Quartz			
Comet				Q	Mineral Survey 5101. See Castle Rock			
Commercial	30	23	7	Q	W. Murphy, Brush Creek	4,700	20	XVI, p. 108
Consolidated Gold & Metals Company (Walker Bros.)	1, 11, 12	24	11	Q, C	Con. Gold & Metals Co., 20 P.O. Place, Salt Lake City, Utah*	6,000	127	See text this report
Continental	19, 20	22	11	P	B. L. Jones, Quincy	6,500	640	XXIV, p. 299; XVI, p. 70
Cooper	14	25	11	C	Goodhue Bros., Genesee	5,000	120	XXIV, p. 270
Copper	11, 14	25	11	C	Optioned in 1920 to Thomas Lane, Angels Camp	5,000	160	XVII, p. 463
Copper Bullion	34	23	10	C	Fred Wickstrom & A. Mattson, Quincy	6,000	180	See text this report
Copper King	12, 13	25	11	C	Sobrero Bros., Genesee	5,300	160	XVII, p. 463
Copper King & Copper Queen	21	26	15	C	Wm. H. Bacon & Lever M. Bacon, Eureka, Utah	6,300	80	XVI, p. 54
Coquette	32	23	7	Q	Frank Douglas, Merrimac, Butte County	4,700	80	XVI, p. 108; XIII, p. 291
Cosmopolitan					See Reward			
Cottonwood				C	Tom Carr, Harry Ryan, Garett Barry and others, Susanville		340	XXIV, p. 271
Coyote	32	23	7	Q	A. E. Darty, Bucks Ranch	5,000	40	XVI, p. 109
Crescent	15, 24	26	9	Q	Crescent Mill & Mining Co., c/o A. H. Redington, Mills Bldg., San Francisco*	4,000	105	XXIV, p. 286; XVI, p. 109; XIII, p. 291; XII, p. 214; XI, p. 330; X, p. 469; VIII, p. 481
Crescent Hill	11	23	9	Q	Crescent Hill Con. Gold Mines Co., c/o M. C. Kerr, Quincy*	5,000	62	XXIV, p. 285; XVI, p. 111
Crown Point	(?) 19	24	11	Q	Mrs. C. J. Lee, Quincy		200	XXIV, p. 286
Crown Point & Summit	11	26	9	Q	Geo. D. Blood, 1495 Euclid Ave., Berkeley	5,000	64	XVI, p. 111
Crystal Lake	8	25	10	M	H. A. & R. L. Kloppenburg, and H. S. Myton, Quincy	6,000	60	XVI, p. 179. See text this report
Cub		23	8	Q	14 mi. S.E. Prattville		40	XII, p. 214
Curtner Placer	2	24	11	P	W. J. Curtner, 1855 16th St., San Jose	5,000		
Dabney	34	26	7	P	Mark L. Miller, Caribou	3,000		
Dabney	34	26	7	Q	D. G. Dabney, Belden	3,000		XVI, p. 112
Daley Bros.	29	22	8	Q				See text this report
Daniel	7, 8	23	7	P	Fannie J. Daniel, Oroville*	5,200	40	

Davis (Smith & Scott)	7	26	9	P & Q	Edman Davis, Crescent Mills	5,280	40	XVII, p. 456
Davison	19	22	7	Q	L. A. Davison, Box 483, Napa	4,500	160	XXIV, p. 286
Deadwood	29	24	8	P	W. C. Robinson, Meadow Valley*	4,700	240	XVI, p. 70
Dean & Yearin	25	23	9	Q	Col. J. Dean, J. Yearin, Nelson Point, via Quincy	5,000	80	XIV, p. 112
Dean	21	26	8	Q	J. S. Williams, Greenville, et al.	3,500		XVI, p. 112
Del Monte	9	26	8	Q	See Shaffer Gold Min. Co.	4,100		XVI, p. 112
Diadem	33	24	8	Q, M	L. L. Clough, Quincy, et al.*	4,750		XVI, pp. 113, 180; XIII, p. 291; XII, p. 214; XI, p. 323; X, p. 486
Digger Ravine					See Ellis			
Dixie Queen	33	23	10		A. Mattson, Quincy	6,000	20	See text this report
Dodge & McAtee	31	23	7	Q	C. O. Dodge, J. O. McAtee, et al., Oroville	5,000	140	XXIV, p. 286
Dominion	4	26	8	P	A. McMillan, Seneca. See Glazier also	4,000	100	XXIV, p. 300; XVI, p. 71; XIII, p. 305; XII, p. 220
Dora	34	24	7		Girard Piano Co., Oakland	5,000		XVI, p. 113
Drader	29	26	9		Dr. C. R. Drader, Greenville	5,000	60	See text this report
Droege	9	26	9	Q	Lindblom Investment Co., Hotel Claremont, Berkeley*	4,200	500	XXIV, p. 287; XVI, pp. 114, 115; XIII, p. 298-301; XII, p. 217; X, p. 473; VIII, p. 480. See text this report
Drury & Pacific		26	9	Q	2 mi. W. Greenville		4,400	XXII, p. 215; X, p. 473
Duncan	17, 18	25	8	Q	W. E. Duncan, Jr., et al., Oroville. See Virgilia also*	3,000	200	XVI, p. 115; XIII, p. 292
Duncan	31	26	12	Q	J. B. Duncan, Genesee, et al.	4,500	240	XVI, p. 116
Dutch Hill	8, 17	26	8	P	Savercool Bros., Seneca, et al.	4,700	100	XXIV, p. 300; XVI, p. 71; XIII, p. 292; XII, p. 215; VIII, p. 482. See text this report
Dutre	30 25	24 24	11 10	P	Walker Investments, Inc., Westwood	4,000	474	
Edison	23, etc.	25	5	P	McLaughlin & Enslow, Oroville	5,000		XVI, p. 72
Edman					See Diadem			
El Dorado	25	24	16	C	Paul Sonognini & L. Dufay, Chilcoot	6,100	100	XVI, p. 55
Elizabeth Con. Gold					See Rich Gulch Con. Gold Mines			
Elizabeth Town Flat	10	24	9	P	S. M. Leavitt, Quincy	3,500	53	XVI, p. 72; XIII, p. 292; XII, p. 215; X, p. 478
Ella					Six mi. N.E. Merrimac, Butte County	4,800		XIII, p. 292
Ellis	(?) 34	26	7	P	H. O. Ellis, Caribou	3,000	60	XXIV, p. 300
Emigrant Hill	2	24	9		Mrs. Whiteney, Quincy	3,600	40	XVI, p. 73; XIII, p. 293; XII, p. 219; X, p. 479

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Name	Sec.	Twp.[1]	Range	Kind of mine[2]	Remarks[3] (Location or ownership)	Elevation, feet	Area, acres	References to reports of State Mineralogist[4]
Engels	32, etc. 4, etc.	28 27	11 11	C	Engels Copper Min. Co., 364 Mills Bldg., San Francisco*	5,300	4,640	XXIV, pp. 271-278; XVII, pp. 464-466; XVI, pp. 55-59; XII, pp. 68-69. See text this report
Erickson					See Australia			XVI, p. 73
Fairfield	34	26	7	P	L. B. Fairfield, Belden			XVI, p. 117
Fairplay	3, 10	24	9	Q	F. E. Thomas, Quincy	3,600	26	
Fall River Con. (Walters)	24	21	7	Q	Nine mi. West La Porte, W. P. Frick, 212 Easton Bldg., Oakland*	4,500	43	XIII, p. 293; XII, p. 216
Feather Fork				P	See La Porte Mines, Inc.			
Feather River Copper Co.					See Snowstorm			
Feather River Pyramid Lime & Cement Co.				ls	See Pyramidal Lime Deposit			
Fenton					See Daniel			
Five Bears	23, etc.	25	11	Q	H. F. Meidinger, 8115 Maryland Ave., Chicago, Illinois*	4,500	204	XVII, p. 466; XVI, p. 118; XIII, p. 290; XII, p. 213 See text this report
Five Bears Mining Co.	(?) 18	23	10	Q	1105 Guaranty Bldg., Los Angeles	4,000	320	XIII, p. 293
Florence Con.					3½ mi. E. Merrimac, Butte County	4,700	60	XVI, p. 59
Folsom & Hunter				C	Lights Canyon, 3 mi. from Engels			XVI, p. 59
Fordham				C	¼ mi. N.E. Gibsonville			XVI, pp. 73, 90
Fordham				P	20 mi. from Quincy on La Porte road		1,176	XIII, p. 293
Four Hills					6 mi. S.W. Johnsville	7,150	140	XIII, p. 293
Frazier					6 mi. N.E. Merrimac, Butte County	4,775		XVI, p. 119
Friendship		23	6					XIII, p. 294
Gallager					4 mi. N. of Johnsville	6,250	120	
Genesee					See Gruss			
Genesee Con.					See Big Cliff, Hinchman, Mountain Lion			
Genesee Placer	26, 27	25	11	P	Lena D. Haun, Quincy*	4,500	90	
Genesee Valley				Q	Same as Gruss (?)			X, p. 476
Gianella	29, 32	23	8	P	Savino Gianella and partners, 701 San Bruno Rd., South San Francisco	5,400	640	XVII, p. 456.
Glacier					Formerly Glazier			See text this report
Gladiator					See Sunnyside			
Glazier	9, 16	26	8	P	Dominion Mines & Develop. Co., 503 Divisadero St., San Francisco	3,300	160	XXIV, p. 300; XVI, p. 74; XIII, p. 295; X, p. 495; VIII, p. 482. See Glacier in text this report
Gloria Mundi	26	24	9	P	J. Larison, Quincy	4,500		XVI, p. 74
Golden Ancient Channel	2, etc.	23	8	P	Golden Ancient Channel Min. Co., San Jose	5,000	1,460	XVI, p. 74
Golden Feather	12	23	10	P	J. W. Fricke, c/o G. F. Weber Co., 601 Mission St., San Francisco, et al.	4,000		XXIV, p. 299, under "Buckhorn"
Golden Gate	30	23	10	P	A. W. Robinson, La Porte	6,000		XVI, p. 91

Golden Gate	29, 30	25	9	Q	W. Clinch, Quincy, et al.	4,500	40	XVI, p. 121
Golden Gulch	30	22	8	Q	C. C. Coffman, 27820 Niles Rd., Hayward	5,000	20	See text this report
Golden Horseshoe	21, 28	26	15	C	Jas. B. Novak, Eureka, Utah	6,150	140	XVI, p. 59
Golden Horseshoe	20, etc.	23	9	P	Golden Horseshoe Mining Co., c/o M. C. Kerr, Quincy*	3,200	160	XXIV, p. 303
Gold Highway	17, etc.	25	8	Q	R. V. Montgomery, Chemeketa Park, Alma, Santa Clara County	4,000	1,500	See text this report
Gold Leaf	5	22	11	Q	J. A. Grove, J. J. Lowry, Cromberg	6,500	-------	XVI, p. 119
Gold Leaf	19, etc.	24	11	Q	Dr. H. D. Look, Box 23, Spring Garden*	5,000	122	XXIV, p. 287; XVI, p. 119
Gold Mountain	14, 15	23	7	P	Gold Mountain Hydraulic & Dredging Co., 201 Grant Bldg., Los Angeles, G. W. Fagg, Manager, Buck's Ranch	5,400	440	XVII, p. 456; XVI, pp. 91, 177
Gold Run	10, 15	22	10	Q	A. Hall, Quincy, et al.	6,500	138	XVI, p. 121
Gold Star	(?) 30	22	8	Q	S. Seaquist, Feather Falls	6,000	-------	See text this report
Gold Stripes	36	27	8	Q	Cassie M. Hamilton, Oroville Inn, Oroville*	5,200	52	XXIV, p. 288; XVI, p. 120. See text this report
Granite Basin Mining Co.	30, etc.	23	7	Q	c/o H. F. Lynn, Grass Valley	5,000	(?) 1000	See text this report
Graves	-------	-------	-------	-------	5 mi. N.E. Merrimac, Butte County	4,730	60	XIII, p. 296
Great Divide	-------	-------	-------	P	Geo. Brunk & Wm. Roddy, Greenville	-------	-------	XVII, p. 457
Greenbower	-------	33	7	P	Henry Greenbower, Meadow Valley	4,800	2,880	XVII, p. 457
	-------	22	8					
	-------	23	8					
Green Ledge	23	25	11	Q	S. C. Young, Quincy*	-------	20	
Green Mountain	23, 24	26	9	Q	Harold Boericke, Primos, Pennsylvania*	4,500	96	XXIV, p. 289; XVI, p. 123; XIII, p. 296; XII, p. 217; X, p. 471; VIII, p. 479. See Jackson in text this report
Greenwood	-------	-------	-------	C	Adjoins Engels, Tom Carr, Susanville	-------	280	XXIV, p. 278
Grubstake & Juaniata	26	23	6	Q	Frank Tolands, Brush Creek	4,500	-------	XVI, p. 124
Gruss	14	25	11	Q&C	Dr. F. Gruss, et al., 12 Geary St., San Francisco	3,800	180	XVII, pp. 466-468; XVI, pp. 124-126; XIII, p. 294; X, p. 476
Hall & Lund	18	24	9	P	A. A. Hall & C. S. Lund, Quincy	3,500		
Hallsted	12	25	7	Q	T. H. & Frank Hallsted, et al., Virgilia*	4,000	-------	XI, p. 326. See text this report
	7, 18	25	8					
Harriman	28	27	11	Q	J. W. Harriman, 919 Gaviota Ave., Long Beach	6,500	-------	XXIV, p. 289
Hawkeye	-------	-------	-------	P	3 mi. S.W. Quincy	-------	-------	X, p. 481
Hazard (Hazzard)	15	26	8	Q	Mrs. Eva Baker, 4 Arcade Bldg., Reno, Nevada	4,500	-------	XXIV, p. 289; XVI, p. 126
Hibernia	-------	-------	-------	-------	2 mi. S.E. Greenville	4,325	40	XIII, p. 297; XII, p. 217; X, p. 473
High Grade	-------	23	6	Q	L. A. Lambert, Brush Creek	-------	-------	XVI, p. 127
Hinchman	6	25	11	C, Q	Genesee Con. Mines Co., 827 Roosevelt Bldg., Los Angeles	4,000	-------	XXIV, p. 278; XVI, p. 127
Hobson	29, 30	26	9	Q	W. F. Roedde, Crescent Mills	5,000	60	XVI, p. 128
Homestake	25	23	6	Q	Horace Waldron, Brush Creek, et al.	4,875	80	XVI, p. 129; XIII, p. 297; XI, p. 323
Homestake	25, 26	24	9	Q	Jas. Lesky, R. J. McKewen, Quincy	4,300	80	XVI, p. 129
Honeycomb	29	24	8	Q	Thos. Halsted, Meadow Valley	4,500	20	XVI, p. 130
Hope (Valentine)	5	24	8	P	A. H. Reese, Meadow Valley	4,500	20	XVI, p. 75
Horseshoe	16	26	8	Q	R. D. Hann, Quincy, Jerry Curtis, Twain	4,000	-------	XVI, p. 130
Hose	26	23	7	Q	W. H. Duncan, Bucks, via Meadow Valley	4,800	-------	XXIV, p. 290

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Hudson					See Jackson			
Hulsman	12	27	10	Q	W. G. & J. F. Hulsman, Susanville	5,500	820	
Hungarian Hill				P	Near Quincy	3,425	133	X, p. 479
Hussleman & Shaw	1,12,13 6,17,18	27 27	10 11	Q	Husselman & Shaw, Susanville	5,000	620	XVI, pp. 130-132; Bul. 50, p. 187
Imperator	13	23	6	Q	L. Hemsath, Brush Creek	5,500		XVI, p. 132
Imperial	34	25	9	Q	Vincent E. Bayless, c/o David J. Heisey, 805 Federal Bank Bldg., Dubuque, Iowa	3,800		See text this report
Independence	30	23	10	Q	A. R. Seymore, Quincy	5,500	80	XVI, p. 132
Indian Falls	3 33	25 26	9 9	Q	Indian Falls Develop. Co., Indian Falls, Cal.*	4,000	577	XVI, pp. 133, 134
Indian (Providence Hill & Miocene)	35, 36	26	8	P	Deeded to State, 1922	4,800	450	XVI, p. 75
Indian Valley	10, 11	26	9	Q	J. W. Prentiss, 42 Broadway, New York City*	4,000	100	XVI, p. 134; XIII, p. 298; X, p. 473. See text this report
Indian Valley Min. Co. (Standart)	11	26	9	Q	Indian Valley Mining Co., Greenville*	4,600		XXIV, p. 296; XVI, p. 164; XIII, p. 301; X, p. 473; VIII, p. 480. See text this report
Indian Valley Silver	32	27	11	Q	Roy Starks, Taylorsville	4,000	80	XVI, p. 135
Iron Dike	2	25	10	C	F. D. Beardsley, 49 King St., Santa Cruz	4,200	140	XXIV, p. 278; XVI, p. 135. See text this report
Iron Queen	8	26	9	M	Chas. Delvin & A. F. Smith	5,000		XVI, p. 180
Jackson (Whitney)	14, etc.	26	9	Q	J. W. Ryan, Crescent Mills, Samuel Altshuler, 2845 Van Ness Ave., San Francisco	4,500	135	XXIV, p. 290; XVI, p. 171. See text this report
Jamie	36	23	6	Q	Estate of Geo. C. Perkins, 659 Kenwyn Rd., Oakland*	4,500	30	
Jamison	25, 26	22	11	Q	See Carnation also			See text this report
Jenkins				Q	G. W. Jenkins, Seneca			XVII, p. 458
Jennie (Jamie?)	25	23	6	Q	Senator Geo. Perkins, Oakland. See Jamie	4,600	20	XVI, p. 137; XIII, p. 305
John Bull & Phoenix				Q	2½ mi. S.E. Greenville	3,600		XIII, p. 298; XII, p. 217
Johnson & Rasmussen	33	27	11	P	c/o J. W. Harriman, Taylorsville	6,500		XXIV, p. 303
Joseph					See Curtner			
Joshua Moss	25	23	6	Q	Joshua Moss & Horace Waldon, Brush Creek	4,500	40	XVI, p. 138
Justice	26, 35	27	8	Q	Mrs. Isabel Williams, Greenville*	5,000	270	XVI, p. 138
Jumbo	18, 19	25	7	P	Chris Gunderson, Belden	3,800	100	XVI, p. 76
Kelly	30	23	10	P	John Kelly	5,700	80	XVI, p. 76
Kennebeck					See Plumas Gold			
King Solomon	27, 34 30	23 25	10 11	P	Lucky Strike Min. Co., Bacon Bldg., Oakland, or c/o H. O. Howard, Lovelock, Nevada	5,500	120	XVI, pp. 77, 176
King Solomon	25	25	10	Q	Cate Bros., Quincy, et al.*	6,800	41	XVI, p. 139; XIII, p. 299. See text this report
La Honda	29	24	8	Q	J. W. McKay, Quincy (?)	5,000		See text this report
La Porte, Inc. (Feather Fork, Marguerite, McFarland)	11, etc. Also Also	22 22 22	9 8 10		Estate of Wallace Dinsmore, c/o C. F. Aaron, Marysville, et al.	5,400	960	XXIV, p. 303; XI, p. 330
La Reina de Ora	35	27	8	Q	A. W. & P. H. James, Box 65, Greenville	5,000		See text this report

Las Plumas					See Onion Valley			
Laura	7	22	13	Q	Kenneth B. Murray, Greenville*	4,500	20	XVI, p. 139
Lava Bed	2	24	8	P	Reliance Securities Co., Meadow Valley*	4,400	20	XVI, p. 77
Leete Syndicate	14	26	9	Q	Nott Leete, 441 Virginia St., Reno, Nevada*	5,000	160	XVI, p. 139; XIII, p. 299
Lena				Q	See U. S. Smelting, Refining & Mining Exp. Co.			
Little California	6	22	8	Q	Lawrence Kittrick, Oroville, et al.	3,000	20	XVI, p. 140
Littlefield	33	27	8	C	F. N. Littlefield, G. W. Young, J. H. Weber, Greenville	5,000	40	XXIV, p. 279
Little Gem				Q	Near Genesee			XVI, p. 140
Little Jamison					See Jamison; also Carnation			
Little Nell	35	23	8	Q	Sutherland Murray, 412 Crocker Bldg., San Francisco. Tyndale Phipps, Quincy	3,000	180	XVI, p. 141
Long Valley	6	26	9	Q	Dr. I. L. Tucker, Oroville, et al.	5,250	80	XVII, p. 458. See text this report
Lott	21	25	6	P	Mrs. Cornelia F. Sank, 1067 Montgomery St., Oroville*	5,000	36	XVI, p. 92
Lucky Boy		27	10	C	Head of Lights Creek			XXIV, p. 279
Lucky S.	28, 33	27	11	Q	Harriman-Blakeman Corp., 27 Williams St., New York City (?)	6,800	1,200	XXIV, p. 290; XVI, p. 141; XIII, p. 300; X, p. 467. See text this report
Lucky Strike	21, 22	25	11	P	H. G. Ericksen, Del Monte Apts., Redding, and T. McGinnis	5,000		
Lucky Strike	4, 5	23	7	Q	A. E. Darby, Bucks Ranch, C. Crane, Oroville	5,500	20	XVI, p. 141
Lucky Strike Co.					See King Solomon			
Magee (Hughes)	27	24	7	Q	J. Magee, Oroville	5,500	20	XVI, p. 142
Magpie	24	26	11	Q	A. L. Beardsley, Genesee	6,000	40	XVI, p. 142
Main Spring	26	24	7	Q	T. B. Lofton, Bucks Ranch	6,000	20	XVI, p. 142
Malloy	28, 33	24	7	Q	P. Malloy, Bucks Ranch	5,000	20	XVI, p. 143
Malvern Hill	18	26	8	P	Frank Soroti, Susanville	3,550		XVI, p 77; XIII, p. 300
Manhattan Gold Min. Co.	28, 33	24	9	P	C. E. Hegard, 130 San Mateo Dr., San Mateo*	5,300	450	XVI, p. 78
Maples Flat Con.	31	25	8	P	Violet J. Mori, Quincy*	4,800	40	XVI, p. 92
Marguerite				P	See La Porte Mines, Inc.			
Martin & Nicoll	35	27	8	Q	Geo. T. Martin & A. J. Nicoll, Susanville	5,500	40	XXIV, p. 291
Mary Ann	32	22	8	Q	R. H. Vermillion, Feather Falls	5,500	40	See text this report
Mayflower	31, 32	23	6	P	I. J. Mullen, Eclipse, et al.	6,300	40	XVI, p. 78; XIII, p. 301
Maynard	26	25	7	P	George Wess, Rich	3,500		XXIV, p. 306
McCarty	14	23	9	Cr		4,000		XVI, p. 54; Bull. 76, p. 165
McCray Ridge Placer	(?) 33	22	11	P	E. C. Kelsey, Quincy, et al.	6,500	600	See text this report
McFarlane				P	See La Porte Mines, Inc.			
Megown	31, 32 5, 6	25 24	8 8	Q	H. B. Hardy, Meadow Valley	5,100	20	XVI, p. 143; XIII, p. 301; XI, p. 324; X, p. 484
Mel-Dick	3	24	9	P	Melvin E. Jepson, Reno, Nevada, et al.			See text this report
Mexican					See Joshua Moss			
Mill Creek	25	24	9	P	Clark Lee, Quincy, et al.	4,000	120	XVI, p. 79
Mohawk (Last Chance)	25	24	16	C	Mrs. H. G. Langworthy, Hotel Golden, Reno, Nevada*	6,250	40	XVI, p. 60

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Name	Sec.	Twp.[1]	Range	Kind of mine[2]	Remarks[3] (Location or ownership)	Elevation, feet	Area, acres	References to reports of State Mineralogist[4]
Moonlight					See Trask & Coffer			
Morning Star	12	22	10	P	Peter Spaich, Johnsville	5,500	760	XVI, p. 79
Morning Star	30, 31	23	7	Q	E. C. Robinson, First National Bank Bldg., Oakland	5,000	40	See Granite Basin in text. XVI, p. 144; XIII, p. 304
Mornington		22	7	P	Mornington Mining Co., 617 Pacific Bldg., San Francisco	2,400	40	XVII, p. 458
Mosquito Creek					See Mystery Gulch			
Moss, Joshua					See under "J"			
Mother Lode, Keystone, Baltimore	23	25	11	Q	Lillian F. Worley, 1144 Grandview St., Los Angeles*	4,000	59	XXIV, p. 288; XVI, pp. 122, 144; XIII, p. 296; X, p. 476
Mountain Chief				Q	West Branch Mill Cr., 4 mi. S.E. Quincy		20	XII, p. 218
Mountain Lily	32, 33	26	9	Q	N. Kertchendorf, Robert Martin, Indian Falls	4,000	40	XVI, p. 146
Mountain Lion	15, 22	25	11	Q	Genesee Con. Mines Co., 827 Roosevelt Bldg., Los Angeles, or 250 Lake St., Reno, Nevada	5,500	80	XXIV, p. 291; XVI, p. 147
Mt. Hough					See Crystal Lake			
Mudhen & Minnie S.	30	23	7	Q	Joseph Peppin, Brush Creek	4,700	80	XVI, p. 147
Murdock	25 30	24 24	16 17	C, Mo.	Mrs. H. G. Langworthy, Hotel Golden, Reno, Nevada	6,500		XVI, pp. 61, 157, 180
Mystery Gulch	20	26	7	Q	Chas. M. Pense, Belden	4,000	20	See text this report
Native Son	24	25	11	C	G. & L. Mining Co., 250 Lake St., Reno, Nevada	6,000	140	XXIV, p. 279; XVI, p. 148
Nelson Creek	22	23	10	P	C. M. Root, Nelson Point	4,000	20	XVI, p. 80
New Century & Whidden	25	23	6	Q	J. A. Hall, Brush Creek; M. A. Whelden, Elks	4,500	23	XVI, p. 148
Newtown Con. (Fairstake & Keystone)	3	24	9	P	H. L. Cate & S. M. Leavitt, Quincy	3,700	200	XVI, p. 80
Newtown Flat	3	24	9	P	S. M. Leavitt, Quincy*	3,700		XVI, p. 80; X, p. 479
New York	10	26	9	Q	See also Plumas Gold Mining Co., c/o Walter H. Parsons, Greenville*	4,500	70	XVI, p. 149. See text this report.
Niagara	13, 14	24	11	P	H. G. Ericksen, Del Monte Apts., Redding, and T. McGinnis	6,500		
Nona Lee	19	26	8	P	Tim Hutchinson, Seneca	3,500		
Northern Placer Min. Co.					See Ray & Traynor			
Ohio Point	17, 18	25	8	Q	See Virgilia Mining Corporation		16	
O. K. & T. C.	34	25	9	Q	Vincent E. Bayless, c/o David J. Heisey, 805 Federal Bank Bldg., Dubuque, Iowa. Sold to State, 1935*	3,800	40	XVI, p. 167. See Imperial in text this report
Oliver	36	23	9	P	J. H. Thomas, 2610 E. 14th St., Oakland	5,500		XVI, p. 81
Onion Valley	5, 6	22	10	P	Las Plumas Min. Co., Los Angeles	6,000		See text this report
Ora Plata					See Lucky S			
Oro Fino	10	22	10	Q	H. W. Hewitt & Bros., Eclipse	5,500	160	XVI, p. 150
Orton				P	See Summit			
Oversight	24	23	9	Q	August Binner, J. E. Wilson, Quincy	4,000	40	XVI, p. 151

Pacific Foundation Corp.	(?) 19 (?) 22	24 25	11 7	Q P	c/o E. L. Flanagan, 2345 Spurgeon St., Santa Ana			XXIV, p. 292
Pappin				Q	Granite Basin	4,600	40	X, p. 491
Peerless Dev. Co.					See Gold Stripes			
Peter	13	26	10	P	Arthur Peter, Taylorsville*	3,500	173	See text this report
Peter	7	26	11	Q	Arthur Peter, Taylorsville*	3,600	41	XVI, p. 152
Peter Henry	8	23	10	P		4,900		XVI, p. 81
Pilot	14, 23	25	11	C	A. P. & J. W. Goodhue, Genesee	4,000	60	XXIV, p. 279; XVII, p. 468; XVI, p. 62
Pilot Peak	9	22	10	Q	Pilot Peak Min. Co., Eclipse, via Quincy	6,800	120	XVI, p. 153; XIII, p. 303; XII, p. 218
Pine Leaf	35	25	8	P	c/o Henry Reimers, Rosemead	5,000	50	XI, p. 325. See text this report
Pioneer	28	26	9	P	Estate of W. P. Boyden, c/o Wolf Cr. Timber Co., 903 Alexander Bldg., San Francisco*	4,500	30	XVI, p. 81
Pioneer Min. Co.	34	26	7	Q	J. N. Henry, Belden, et al.	3,000		XVI, p. 153
Pliocene	9	26	8	P	Pliocene Mining Co., Bransford Apts., Salt Lake City*	4,050	99	XXIV, p. 306; XVI, p. 82
Plumas Amalgamated	29, 30	26	9	Q	Plumas Amalgamated Min. Co., 251 Russ Bldg., San Francisco	5,200	380	XVI, p. 153
Plumas Bonanza	20	23	10	Q	W. A. Wall, Nelson Point, via Quincy, et al.	4,200	200	XVI, p. 154
Plumas Con. Min. & Milling Company	11	26	9	Q	c/o Hammon Engineering Co., Greenville*		118	See Indian Valley also
Plumas County Min. Co.					See Indian Valley, New York & Droege			
Plumas Develop. Co.	1, etc.	25	5	P	J. D. Williams, Greenville	6,000	160	XVI, p. 82
Plumas-Eureka	26, etc.	22	11	Q	Plumas-Eureka Corp., Phillips trustees, A. J. Peters, chief trustee, No. 1 Federal St., Rm. 911, Boston, Mass.*	6,000	2,744	XXIV, pp. 292, 293; XVI, pp. 155-157; XIII, p. 303; XII, p. 219; XI, p. 330; X, p. 482; VIII, pp. 476-479. See text this report
Plumas-Eureka Annex (Jamison)					See Jamison in text this report			
Plumas Gold (Kennebeck)	10	26	9	Q	Plumas Gold Mining Co., c/o Walter H. Parsons, Greenville*	4,500	1,230	XXIV, p. 294; XVI, p. 138. See New York in text this report
Plumas Gold					See Sunnyside			
Plumas Imperial	17, etc.	24	9	P	Towle Bros. Lumber Co.	4,500		XIII, pp. 298-303; XII, p. 219; X, p. 479
Plumas Investment Co.	30, 34 2 etc.	25 24	8 8	P	c/o W. P. Hammon, 351 California St., San Francisco	4,600	1,400	XVI, pp. 82, 93, 177
Plumas Jumbo					See Murdock			
Plumas Klondike	7	23	10	P		4,900		XVI, p. 83
Plumas Mohawk	3	22	11	Q	Plumas Mohawk Gold Min. Co., Johnsville	6,000	300	XVI, p. 157; XIII, pp. 294-297
Plumas National					See Drader			
Plumas Quartz	32, 33	26	10	Q	Kenneth B. Murray, Greenville*	3,500	15	See text this report
Plumas Water & Mining				P	Silver Lake			X, p. 483
Pocahontas	12	22	6	Q	J. A. Hall, Brush Creek, G. M. Sparks, Oroville	4,200	60	XVI, p. 158
Pocahontas				C	Mountain Meadow District			XII, p. 69
Polar Star	15	25	11	C		4,000		XVI, p. 62
Powell	1	26	8	Q	M. M. Powell, Greenville	5,500	40	See text this report
Premium	32, 33	26	10	Q	P. A. Young, Taylorsville, and F. W. Young, Quincy (?)	4,500		XVI, p. 158. See text this report

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Name	Sec.	Twp.[1]	Range	Kind of mine[2]	Remarks[3] (Location or ownership)	Elevation, feet	Area, acres	References to reports of State Mineralogist[4]
Prospect	13	26	9	Q	W. A. Kingdon, Crescent Mills*	3,900	20	XVI, p. 159; XIII, p. 289
Pyramidal Lime	6, etc.	25	8	ls	Deeded to State, 1933	4,000	480	XXIV, pp. 310, 311; XVI, p. 178
Queen	19, etc.	22	11	P	B. L. & Mrs. E. E. Jones, Quincy	6,500	670	XVI, p. 83
Quincy Mining & Water Co.				P	Three mi. west of Quincy	3,800	2,200	XIII, p. 304; XII, p. 219
Rainbow	25	22	7	Q	A. L. Allen, Feather Falls	4,500	40	See text this report
Ray & Traynor	1	23	11	P	L. N. Prugh, Sacramento	5,000		XVI, p. 84
Ready Bullion	18	21	12	Q	Ready Bullion Mining Co., Sacramento	6,800		See text this report
Red Ravine & Red Rose	25	22	10	P	John Bevilauqua	6,000		XVI, p. 84
Red Slide	4	22	10	P	Margaret N. Hart, 1823 Turk St., San Francisco	6,500	50	XVI, p. 84
Reinmiller				C	North of Engels		1,120	XVII, p. 468
Reising	9	25	8	Q	H. C. Flournoy, Quincy, et al.*	3,300	20	XXIV, p. 294; XVI, p. 159. See text this report
Reward (Cosmopolitan)	34 3	26 25	11 11	C	I. L. Rosenthal, 117 Post St., San Francisco*	4,200	200	XXIV, p. 280; XVI, p. 108; XII, p. 68
Rich Gulch (Elizabeth)	1, 12	25	7	Q	Rich Gulch Con. Gold Mines, Joseph Moss Little, 3621 Broadway, Oakland*	3,900	127	XXIV, p. 294; XVI, p. 116; XIII, pp. 299, 300
Rich Point	35	23	8	P	Rich Point Mining Co., E. N. Hawkins, Strand Hotel, San Francisco	4,000		XVII, p. 459
Riodel	1 35	26 27	8 8	Q	W. J. Jordan & Joseph Bigler, Greenville	5,500	140	See text this report
Rio Vista	4, etc.	23	10	P	Rio Vista Mining Co., Wm. Black, 2726 Maxwell Ave., Oakland*. Sold to State	4,100	800	XVI, pp. 84, 89
Riverdale	10	24	9	P	Nick Schiavi, c/o A. Purdy, 2275 100th Ave., Oakland*	3,450	119	XVI, p. 85; XIII, p. 292; XII, p. 215; X, p. 478
Robinson (Morning Star & Trenton)				Q	See Granite Basin Mining Co. 8 mi. N.E. Merrimac, Butte County	4,750		XIII, p. 304
Rogers	14	23	7	Q	A. L. Rogers, Bucks Ranch	5,500		XVII, p. 460
Rose Quartz	10	22	10	Q	Rose Quartz Mining Co., Nicolaus Bldg., 8th and K Sts., Sacramento	6,000	180	XVI, p. 161
Round Lake (Dixie Queen)	18	21	12	Q	Round Lake Min. Co., Insurance Exchange Bldg., San Francisco	6,500	40	XVI, p. 162
Round Valley	10, 15	26	9	Q	Near North Canyon			X, p. 475
Ruby	13	27	10	C	O. B. Camp, Engelmine	5,000		XXIV, p. 280; XVII, p. 469
Saint Nicolas (Bushman)	34	25	9	Q	Nick Borentz, Quincy	3,350	20	XVI, p. 163; XIII, p. 288; XII, p. 214; XI, p. 328
Sanhedrin	8	23	8	P	Sanhedrin Mining Co., A. W. Craig, Sec., 1371 Oak St., San Francisco	5,000		XVII, p. 460; XVI, p. 94
San Jose	17	26	8	P	H. F. Kelly, Caribou	3,500	200	XVI, p. 85
Savercool	5, etc.	26	8	Q, B	K. B. Murray & W. T. Treleaven, et al., Greenville*	4,000	80	XVI, p. 164; XIII, p. 305; X, p. 493. See text this report
Saw Pit	6, 8	22	10	Q	A. W. Dozier, 529 31st St., Oakland, & E. P. Turner*	6,500	78	See text this report
Scad Point (& Deadwood)	28	24	8	P	W. C. Robinson, Meadow Valley*	3,550	380	XVI, p. 93

Scott, Fred	16, 17	26	8	P	W. W. Sharp, 512 Ochsner Bldg., Sacramento. Sold to State, 1934	3,500	83	XVI, p. 86
See, & Seren & Specimen				Q	Granite Basin	4,900	20	X, p. 490
Seneca Con				Q	See Shaffer			
Seneca Eureka					See Hazzard (Hazard)			
Shaffer (White Lily, Del Monte, etc.)	9, etc.	26	8	Q	Shaffer Gold Mining Co., C. B. Shaffer, 33 S. Clark St., Chicago, Illinois*	3,500	760	XXIV, p. 295; XVII, p. 460; XVI, pp. 112, 170. See text this report
Shenandoah					Head of French Ravine, 12 mi. N.W. Spanish Ranch	2,350		XIII, p. 305; XII, p. 220; XI, p. 324
Shenandoah	28	25	7	Q	J. W. Schulze, of Rich & Geo. H. Pearce, 1263 N. Pilgrim St., Stockton	4,500	100	XXIV, p. 295
Shoofly	32, 33 3, etc.	26 25	9 9	C	G. H. Goodhue, Quincy	4,000	420	XVI, p. 62
Sierra Nevada Mining Corp.					See Bunker Hill			
Smith (Holloway)	11	22	10		J. Smith, Eclipse via Quincy	5,000		XVI, p. 93; XIII, p. 297
Snowstorm	17, etc.	27	11	C	Feather River Copper Co., 15 Central Bldg., Phoenix, Arizona	4,580	450	XVII, p. 469
Sonoma				Q	8 mi. N.E. Merrimac, Butte County	4,950		XIII, p. 306
Southern Eureka					See Indian Valley Mining Company			
Specimen	24	23	6	Q	Mrs. Sarah Jolly, Oroville	4,900	20	XVI, p. 165; XIII, p. 306; X, p. 490
Standart					See Indian Valley Mining Company			
Star of Plumas					See Sanhedrin			
Summit	2, etc.	25	7	Q	A. N. Cameron, Seneca*	4,000	80	XXIV, p. 297; XVI, p. 166
Sunnyside	5, etc.	21	11	P	B. L. Jones, Quincy	7,000	200	XXIV, p. 307; XIII, p. 295
Sunnyside	17, etc.	26	8	P	Merrill Lucas, 427 Highland Ave., Tracy*	3,500	160	XXIV, p. 307; XVI, p. 86; XIII, p. 306
Sunrise	18, 19	22	9	P	John J. Mullen, et al., La Porte	4,500	560	XXIV, p. 307
Swiss	18	26	8	P	W. B. Perry, Greenville	4,500	145	XVI, p. 87; XIII, p. 307
Synthetic Iron Color Co.	32	27	8	B	c/o N. M. Zoph, Box 1157, Richmond	5,000	120	See text this report
Taylor Diggins	29, etc.	26	11	P	J. M. Longnecker, 357 S. Hobart Blvd., Los Angeles*	5,500	110	XVI, p. 94; XIII, p. 289
T. C. Claim					See O. K.			See Imperial in text this report
Tefft	11	23	9	Q	J. U. Tefft, Quincy	6,000	140	XVI, p. 167
Telge				C	See Beardsley			
Trask & Coffer	24, 25 19, 30	27 27	10 11	C	C. L. Eaton	4,225	300	XXIV, p. 280; XVII, p. 470; XVI, p. 61
Underwood & Martin	7	24	12	P	T. & J. Underwood	6,000	120	See text this report
U. S. Smelting	7 12	24 24	12 11	C	U. S. Smelting, Refining & Mining Exp. Co., Newhouse Bldg., Salt Lake City, Utah*	6,700	136	XXIV, p. 280; XVII, p. 468
Valentine	30	22	13	Q	Geo. H. Stephan, et al., Quincy*	4,700	20	XVI, p. 168
Valley View				Cr	Near Greenville			XVI, p. 54; Bull. 76, p. 166
Virgilia	17, 18	25	8	P & Q	Virgilia Mining Corp., Virgilia, California, et al.*	2.500	180	See text this report

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Walker	5, etc. 30, etc.	24 25	12 12	C	Walker Min. Co., 818 Kearns Bldg., Salt Lake City, Utah*	6,500	1,140	XXIV, pp. 280-285; XVII, pp. 471-473; XVI, pp. 63-64. See text this report
Walker Bros.					See Consolidated Gold & Metals Company			
Walters					See Fall River Con.			
Wardlow	10, 11	26	9	Q	H. D. Wardlow, et al., Greenville	4,700	75	XVI, p. 169
West Elizabeth	32	22	11	P	West Elizabeth Mining Co., Johnsville	5,500	510	XVI, p. 88
Western					See Cameron			
Western Star	3, 9	25	9	P&Ls	Western Star Gold Mining Co., c/o Geo. H. Bennett, Paxton*	3,000	200	See text this report
Wheelock				Q	Leander Wheelock & J. G. Reynolds, Crescent Mills. (Claim at Crescent Mills)		20	XVII, p. 461
White Hope					See Riodel			
White Horse	12	26	8	P&Q	James & J. G. Reynolds, Crescent Mills	5,500	40	XVII, p. 461
White Lily					See Shaffer			
White Oak & Black Oak	34	25	9	Q	H. P. Wormley, Quincy	3,700	40	XVI, p. 169; XIII, p. 288
Whitney					See Jackson			
Walters (Fall River)	24	21	7	Q	W. P. Frick, 212 Easton Bldg., Oakland*	4,500	60	XVI, p. 172; XIII, p. 293; XII, p. 216
Workman				Q	5 mi. N.E. Merrimac, Butte County	4,700		XIII, p. 308
Wyatt	35	23	7	Q	W. A. Wyatt, Susanville	4,000	60	XXIV, p. 297
Zola	10, 11	24	9	Q	C. G. Hankel, Quincy, et al.	3,500	140	See text this report

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LIMESTONE

Plumas County is well supplied with limestone, and some production has been made. The geologic ages of several different varieties have been determined by Diller,[1] who has also described the deposits.

The Montgomery limestone, of Silurian age is found on Montgomery Creek, two and one-third miles south of Taylorsville. It is light to dark bluish-gray and cleaves into plates. It has occasional knots or bunches of black chert. The form of the limestone is lenticular, and the largest lentil has a thickness of 60 ft., with a length of about 200 ft. The strike is approximately parallel to the crest of Grizzly Mountains, and the dip is to the southwest.

Five of these limestone lentils have been found at intervals along the western border of the quartzite between Taylorsville and the fortieth parallel. The first is exposed in a tunnel, two miles south of Taylorsville, on the east slope, near the crest of the ridge, where it has a thickness of 20 ft. The second is on the south bank of Montgomery Creek, forming prominent cliffs at an altitude of about 4000 ft. The third and largest lentil, 60 ft. in thickness, is on the crest of Grizzly Mountains at their northern end, having an altitude of nearly 7000 ft. Two miles farther southeast, in the cliff overlooking the Devils Punch Bowl, is a lentil of limestone about 15 ft. in thickness and exposed for 60 ft.

Lentils of limestone occur in the Shoo Fly formation, of Carboniferous age, in Sec. 14 and 15, T. 25 N., R. 9 E. Some of them attain a thickness of over 50 ft. and form conspicuous ledges on the spur half a mile east of the bridge where the road from Quincy to Crescent Mills crosses Clear Creek.

The Hosselkus limestone, of Triassic age, is dark blue on fresh fracture, but weathers light gray, and contains a few veins of white calcite. It is thin bedded and in some places decidedly slaty, forming prominent ledges on the divide between Genesee Valley and Hosselkus Creek, a mile northeast of the Hosselkus ranch, from which the limestone was named. It forms two hills on the crest of this divide, running nearly northeast for half a mile, then turns northwest and crosses the valley of Hosselkus Creek, but soon disappears. This continuous exposure is only about two miles in length, but an isolated outcrop occurs at each end along the strike, one at the head of a ravine tributary to Peters Creek and the other near the road a mile east of Hosselkus, increasing the total length of exposure to about six miles, but not extending it beyond North Arm to the northwest of Genesee Valley to the southeast.

Several isolated outcrops of the Hosselkus limestone occur on the lower slope of Grizzly Mountains, a mile southwest of the mouth of Little Grizzly Creek. They contain irregular patches of cherty matter. These outcrops are approximately in line and make an exposure nearly a mile in length. The general strike is N. 5° E. and the dip 70° NW. into Grizzly Mountains. Over 50 ft. of limestone is exposed. This limestone is prominent to the northwest in the Lassen Peak quadrangle and in the Redding quadrangle of Shasta County. The greatest thick-

[1] Diller, J. S., Geology of the Taylorsville Region, California: U. S. Geol. Survey Bull. 353, 1908.

ness of the Hosselkus limestone in the Taylorsville region is about 140 ft.

The Thompson limestone, of Jurassic age, is gray and somewhat shaly, and on its weathered surface in places are round, oblong, or irregular patches of darker more or less granular calcite. This limestone outcrops in two belts. The main belt crosses the west slope of Mount Jura, and the crest belt lies along the crest running south from the summit of Mount Jura.

The main belt is irregular and interrupted, extending across the west slope of Mount Jura from Mr. Thompson's on North Arm (Sec. 23, T. 26 N., R. 10 E.) to the lower slope of Grizzly Mountains, a mile southeast of Huntington's, and the most prominent and accessible exposures are near the north end, where it has been burned for lime. At Thompson's it forms a bluff, strikes N. 70° W., dips 40° SW., and has a thickness of 30 ft.

A mile to the southeast the limestone is interrupted and offset nearly half a mile to the east. At an elevation of 4100 ft. outcrops begin again and have furnished material for lime. The mass at this point has a thickness of 40 ft. and curves in position from N. 53° W. to N. 28° W., with a dip of about 40° to the southwest. The bottom layer of limestone is massive, six feet in thickness, and has a rough weathered surface. Below the limestone redding and gray beds are exposed interstratified with limy layers. At this locality the limestone changes its course from southeast to southwest and follows a prominent spur toward Taylorsville. The red shaly limestone and calcareous shale is more abundant and continuous than the lentils of gray limestone, and the whole mass is folded and displaced in a complicated fashion along lines running southeast, producing a local extension in that direction before the general course is resumed a mile farther southwest. On the lower slope of Grizzly Mountains, in SW¼ Sec. 7. T. 25 N., R. 11 E., the terminal outcrops of this belt of Thompson limestone appear in three isolated ledges lying along a line extending nearly east and west. The exposures range from 4 ft. to 25 ft. in thickness.

The only outcrop of Thompson limestone lying outside of the main belt just described is in the crest belt of exposures extending south from the summit of Mount Jura. It occurs near the top of the spur rising northwest from the mouth of Hinchman Ravine, at an elevation of about 5100 ft. The total thickness of the formation at this point is probably less than 20 ft. and its outcrop is scarcely half a mile in length.

S. Gallegos of Quincy has recently located mining claims at the north end of the Thompson limestone deposit. He states that the limestone is suitable for use in sugar refining, and that he expects to ship from Veramont Station on the Indian Valley Railroad.

Pyramidal Lime Deposit. (Feather River Pyramid Lime and Cement Co.) Owner, H. C. Flournoy, Quincy. Location, Secs. 6, 7 and 8, T. 25 N., R. 8 E., on the Western Pacific Railroad at Virgilia. The property has an area of 960 acres, 480 acres of which are patented. It lies in the high ridges and steep slopes between the North Fork of Feather River and the East Branch.

The following comments on the geology and analyses are extracts from a report on the deposit by Edw. H. Scott. The formation is a

sedimentary marine deposit of limestones, calcareous shales and some strata of possibly truer slates. It is part of the Cedar formation of Diller and belongs to the Jura-Trias period. To the east of the lime deposit at Rush Creek lies a body of conglomerate 100 ft. wide. To the east of the conglomerate lies a body of black slate 50 ft. to 60 ft. wide; while to the west of the lime belt are shales. The general strike of the lime belt is N. 30° to 35° W. with a dip to the east of 70° to 80°. At Cherry Peak the limestone is 800 ft. wide.

An analysis follows of a composite sample of the lime, including layers of calcareous shales that are found interbedded with the limestone in parts of the deposit, with an analysis of Belgian "Natural Portland" cement-rock for comparison.

	Composite	*Belgian 'Natural Portland'*
Iron Oxide, Fe_2O_3	1.3%	1.0%
Alumina, Al_2O_3	6.4	3.95
Silica, SiO_2	14.0	15.75
Magnesia, MGO	4.7	0.49
Lime, CaO	34.5	43.10
Carbon dioxide, CO_2	32.3}	35.29
Water	6.4}	

Another analysis follows of a composite of 11 samples of this limestone, with some average high-line rock of the Standard Portland Cement Co. for comparison. (For chemical symbols, see above.)

	Composite	*Average high-line rock. Standard Portland Cement Co., Napa Junction*
Water	3.4%	---
Iron Oxide	0.4	1.21%
Alumina	1.6	2.98
Magnesia	0.3	1.33
Silica	6.0	6.87
Lime	49.1	47.30
Carbon dioxide	39.1	38.12

Below is an analysis of slate which is separated from the limestone by 100 ft. of conglomerate, with an analysis of a slate used in the manufacture of Portland cement at Rockmart, Georgia.

	Slate dried	*Rockmart slate*
Iron oxide	9.1%	4.45%
Alumina	20.4	23.65
Silica	65.2	57.4
Lime	2.7	3.23
Carbon dioxide	2.1}	6.80
Water	--}	

The slate mixed with the limestone in the proportion of about six parts of limestone (composite) to one of slate would make good material for Portland cement. It is possible that the shales to the west will also afford material suitable for adding to the limestone to make a Portland cement mixture.

At the place where the following sample was taken, the limestone was of fine appearance, and for a width of 150 ft. from the hanging-wall, it was entirely without shale strata; and strong croppings showed a total width of 350 ft. with no shale apparent.

	Limestone, dried
Iron oxide and alumina	1.6%
Magnesia	0.3
Silica	2.9
Lime	53.3
Carbon dioxide	41.9

The deposit has been developed by means of a tunnel 275 ft. long; and a small amount of the limestone has been quarried. This has been burned in a pot-kiln 20 ft. high and 10 ft. in diameter at the base, with a capacity of 350 barrels of burned lime. Lime burned in 1919 and 1920 amounted to about 2500 barrels and in 1927 to 350 barrels. This lime was sold for building purposes.

This deposit has a length of several miles with very good widths; and the analyses given above indicate that it is commercially important, especially when the convenient railroad transportation is considered.

Western Star Gold Mining Co. holds a deposit of travertine in Sec. 3 & 10, T. 25 N., R. 9 E. G. H. Bennett is president and J. D. McLaughlin of Quincy is secretary of the company. S. Gallegos of Quincy holds an option on the property. The deposit is just across the creek from the Indian Valley Railroad and within a few hundred feet of the new line of the Western Pacific. Paxton is four miles southwest. The road from Quincy to Crescent Mills crosses one end of the property.

The travertine limestone or marble covers an area of several acres, and depths of 20 ft. or more can be observed where a small gulch has been formed by erosion. Depths of eight and ten feet can be observed elsewhere where there are cracks and crevices in the deposit. The springs that have formed this travertine are active in the lower part at the present time. The bottom of this deposit is probably very irregular, and depths must be determined definitely at numerous places before an accurate estimate of tonnage will be possible. Assessment work only has been done to date.

The travertine is well banded and seems to merit attention as ornamental stone. S. Gallegos, who is interested in the deposit only as a source of chemical grades of limestone, has supplied the following analyses. He states that No. 1 and 2 are by Hanks, and No. 3 by Cowell Cement Co., both of San Francisco.

	No. 1	*No. 2*	*No. 3*
Silica	0.07%	0.07%	0.26%
Iron oxide	0.14	0.33	0.20
Alumina	0.05		0.06
Lime	54.72	55.20	54.94
Magnesia	0.36	0.50	0.62
Ignition loss	44.42	44.05	43.84
Calculated			
Calcium carbonate	97.65	98.52	98.10
Magnesium carbonate	0.75	----	1.30

Bibl: (Plumas County limestone in general) U. S. Geol. Survey Bull. 353, pp. 15, 16, 17, 23, 30, 41; Chapter of State Mineralogist's Report for Biennial Period 1917-1918, Plumas County, pp. 21, 24, 40, 42, 45, 178, 179; State Mineralogist's Report XXIV, pp. 310, 311.

MANGANESE

Braito Property is in Sec. 26, T. 26 N., R. 9 E., near Crescent Mills. According to Bull. 76 [1] of this division, 20 carloads of manganese ore were shipped from this property up to Jan. 1, 1918, by Noble Elec-

[1] Bradley, W. W.; Huguenin, E.; Logan, C. A.; Tucker, W. B.; Waring, C. A.; Manganese and Chronium in California, Calif. Division of Mines, Bull. 76, p. 53, 1918.

tric Steel Co., for making ferro-manganese at their Heroult electric smelter.

Crystal Lake Manganese Group is in Sec. 8, T. 25 N., R. 10 E. According to a location notice posted on this property, Ben Egbert and George Holloway located the Gallegos No. 2 quartz claim on the manganese deposit on July 1, 1928. The property is at an elevation of 7000 ft. and is reached from Quincy by the road to Crystal Lake and the Mt. Hough Lookout Station. The manganese occurs in reddish chert, which is veined with white quartz. At the north end of the deposit is an open cut exposing six feet to seven feet of hard, black manganese ore showing a few veinlets of white quartz. Sorting is apparently necessary to keep the silica low. Old workings show for a distance of several hundred feet along the strike of the deposit but most of them have caved. One old stope opening to the surface indicates that a width of four feet to five feet of manganese ore was mined to a depth of at least 15 ft. to 20 ft. At this point the white vein quartz, associated with the manganese, contains specular iron. Much of the softer manganese ore contains brown oxide of iron. The strike is northwest and the dip is roughly 70° to the southwest. The appearance of this deposit, when visited in 1936, indicated that no production had been made for years.

A. D. McMillan of Seneca reports that he has a manganese prospect three miles northeast of Seneca or five miles from Almanor siding on the Western Pacific railroad. He states that samples containing 26% to 56% manganese have been obtained over an area 150 ft. wide by 500 ft. long.

SACRAMENTO FIELD DISTRICT

C. A. Logan, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. Laizure, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field district are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. Tucker and R. J. Sampson, Mining Engineers

Reports covering the mines and mineral resources of most of the counties in the Los Angeles field division are now available, and field work at present is confined to investigations for special reports upon Inyo, Mono and Los Angeles counties.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

The first installment of the manuscript for Bulletin 113, "Minerals of California," by Dr. Adolf Pabst, has now been submitted to the Geologic Branch of the Division of Mines for final editing and publication. This bulletin will be thoroughly up-to-date so far as our present knowledge goes. Quoting from Dr. Pabst:[1]

In this bulletin the preferred mineral name (indicated first in large bold-faced type) will be that approved by the Committee on Nomenclature of the Mineralogical Society of America. This organization together with the British Mineralogical Society have, by means of joint meetings of their respective committees on nomenclature, been able to come to unanimous agreement in recommending the adoption of certain mineral names which have hitherto been inconsistently employed.

The following list of minerals, with names to be discarded placed in parentheses, is given in a mimeographed "Report on Committee on Nomenclature, Mineralogical Society of America, 1935."

Though not yet finally approved for adoption by the Society, this list has been unanimously recommended for adoption by the Committee:

Analcime (analcite)
Anatase (octahedrite)
Argentite (argyrite)
Arsenopyrite (mispickel)
Autunite (calcouranite)
Azurite (chessylite)
Bornite (erubescite)
Chabazite (chabasite)
Chalcopyrite (chalkopyrite)
Chrysoberyl (cymophane)
Cinnabar (cinnabarite)
Cordierite (iolite, dichroite)
Euclase (euklase)
Feldspar (feldspat, felspar)

[1] Pabst, Adolph, Revision of "Minerals of California": Geol. Soc. Am., Program and Abstracts of the thirty-sixth annual meeting (Cordilleran Section) Univ. Cal., Berkeley, April 9, 1937.

"The first catalogue of minerals of California was published by W. P. Blake in 1866, and listed 75 species. The forthcoming bulletin will mention about 420 different minerals, not including varieties, whereas the Bulletin Number 91 issued about 15 years ago listed 386. During this interval, nine new species have been described from California and about 35 minerals, not previously reported from the State, have been described in the literature. To offset this gain, about a dozen names of species or varieties, which were described, will be omitted.

"In revising the old Bulletin, the entire mineralogical literature of California has been re-examined, 1500 papers being consulted. The number of references in the old edition, 379, has been increased by over 300, but only about 200 of the added references are to papers that have appeared since 1922. More than 100 references to the older literature have been added and a few have been deleted."

Fluorite (fluorspar)
Gypsum (gypsite)
Halite (salt, rock-salt)
Hematite (haematite)
Hemimorphite (calamine) zinc silicate
Idocrase (vesuvianite)
Kyanite (cyanite)
Labradorite (labrador)
Magnesite Magnesium carbonate
Nepheline (nephelite)
Olivine (chrysolite)
Orthoclase (orthoklase)
Phenakite (phenacite)
Plagioclase (plagioklase)
Pyrite (pyrites, iron-pyrites)
Scapolite (wernerite)
Sepiolite (meerschaum)
Sillimanite (fibrolite)
Smithsonite Zinc carbonate
Sphene (titanite)
Spondumene (triphane)
Stibnite (antimonite)
Torbernite (cuprouranite)

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From January 3, 1937, to and including April 3, 1937, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY					
Kettleman North Dome Assoc.	28	21 S.	17 E.	56	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	78	Kettleman North Dome
Standard Oil Co.	33	21 S.	17 E.	38	Kettleman North Dome
Standard Oil Co.	33	21 S.	17 E.	81	Kettleman North Dome
IMPERIAL COUNTY:					
Carl M. Einhart, Trustee	13	11 S.	13 E.	11	
National Dry-Ice Corp.	2	11 S.	13 E.	5	
National Dry-Ice Corp.	2	11 S.	13 E.	6	
Pacific Imperial Dri-Ice, Inc.	13	11 S.	13 E.	12	
KERN COUNTY:					
Belridge Oil Co.	35	27 S.	20 E.	3-35	Belridge
Belridge Oil Co.	35	27 S.	20 E.	24-35	Belridge
Belridge Oil Co.	1	28 S.	20 E.	21-1	Belridge
Reward Oil Co.	34	27 S.	20 E.	6	Belridge
Geo. Goodrum	24	25 S.	18 E.	Baron 1	Devils Den
Berry Holding Co.	15	30 S.	29 E.	Duff-Shell 6	Edison
Metro Petroleum Corp.	6	30 S.	29 E.	Metro 1	Edison
The Superior Oil Co.	36	29 S.	28 E.	Crome Comm. 1	Edison
I. J. Banducci	26	29 S.	27 E.	Ticehurst 2	Fruitvale
Exeter Oil Co., Ltd.	21	29 S.	27 E.	Henry 2	Fruitvale
Edward Gieck	23	29 S.	27 E.	Greeley 1	Fruitvale
H. & H. Oil Co.	23	29 S.	27 E.	Neff 2	Fruitvale
E. J. Kasey and Associates	23	29 S.	27 E.	Kasey 1	Fruitvale
Paul L. Kelley	23	29 S.	27 E.	Greely 2	Fruitvale
Harry H. Magee	23	29 S.	27 E.	Douglass 1	Fruitvale
Harry H. Magee	23	29 S.	27 E.	Gilmore 1	Fruitvale
Magnet Oil Co.	21	29 S.	27 E.	Anderson 4	Fruitvale
Meridian Oil Co.	23	29 S.	27 E.	Turner 2	Fruitvale
Pal-Pen Oil Co.	23	29 S.	27 E.	Barbara 1	Fruitvale
Pal-Pen Oil Co.	23	29 S.	27 E.	Pal-Pen 1	Fruitvale
Seahawk Petroleum Co., Ltd.	23	29 S.	27 E.	I-C	Fruitvale
Trico Oil and Gas Co.	23	29 S.	27 E.	Knowles 2	Fruitvale
Trico Oil and Gas Co.	23	29 S.	27 E.	Knowles 3	Fruitvale
Western Gulf Oil Co.	21	29 S.	27 E.	25-KCL-B	Fruitvale
Western Gulf Oil Co.	21	29 S.	27 E.	A. C. West 2	Fruitvale
Apex Petroleum Corp., Ltd.	10	28 S.	27 E.	10-1	Kern River
Bishop Oil Co.	23	28 S.	27 E.	8	Kern River
California Star Oil Co.	22	28 S.	27 E.	7-80	Kern River
California Star Oil Co.	22	28 S.	27 E.	9-40	Kern River
Dougan Oil Co.	17	28 S.	27 E.	Newhouse 1	Kern River
Dougan Oil Co.	17	28 S.	27 E.	Newhouse 2	Kern River
H. C. L. & Associates	36	28 S.	27 E.	Lease 1 1	Kern River
Hub Oil Co.	8	28 S.	28 E.	McNeil 1	Kern River
Italo Petroleum Corp.	17	28 S.	27 E.	Newhouse 1	Kern River
Thos. W. McManus	2	29 S.	28 E.	Tom McManus 2	Kern River
Thos. W. McManus	2	29 S.	28 E.	Tom McManus 3	Kern River
Thos. W. McManus	2	29 S.	28 E.	Tom McManus 4	Kern River
Oils Incorporated	13	28 S.	27 E.	Seven Spot 2	Kern River
Pioneer Oil Co.	18	28 S.	28 E.	3	Kern River
Republic Petroleum Co.	24	28 S.	27 E.	Cal Tech 1	Kern River
Republic Petroleum Co.	24	28 S.	27 E.	Strassburger 12	Kern River
Republic Petroleum Co.	24	28 S.	27 E.	Strassburger 15	Kern River
Republic Petroleum Co.	24	28 S.	27 E.	Strassburger 16	Kern River
Seskayden Oil Co.	17	28 S.	27 E.	Seskayden-Sesnon 3-A	Kern River
Seskayden Oil Co.	17	28 S.	27 E.	Seskayden-Sesnon 4-A	Kern River
Standard Oil Co.	24	28 S.	27 E.	Ward Fee 3	Kern River
Standard Oil Co.	24	28 S.	27 E.	Ward Fee 4	Kern River
Standard Oil Co.	24	28 S.	27 E.	Ward Fee 5	Kern River
Geo. Terry & Associates	4	29 S.	28 E.	Central Point 1-A	Kern River
The Texas Co.	23	28 S.	27 E.	Lehmann 6	Kern River
Tide Water Associated Oil Co.	23	28 S.	27 E.	52	Kern River
M. H. Whittier Co., Ltd.	16	28 S.	27 E.	Cauley 4	Kern River
Robert S. Wight	13	28 S.	27 E.	1	Kern River
Standard Oil Co.	2	26 S.	20 E.	United 3	Lost Hills
The Texas Co.	11	26 S.	20 E.	Theta 2	Lost Hills
Tide Water Associated Oil Co.	11	26 S.	20 E.	Williamson 9-A-3	Lost Hills
Albert S. Clore	20	30 S.	22 E.	Laymance 2	McKittrick

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
Franco Western Oil Co.	8	30 S.	22 E.	13	McKittrick
Welport Oil Co.	26	29 S.	21 E.	18	McKittrick
Birch Ranch & Oil Co.	22	32 S.	23 E.	Goldman 2	Midway
C. C. M. O. Co.	21	32 S.	23 E.	23	Midway
C. C. M. O. Co.	21	32 S.	23 E.	26	Midway
C. C. M. O. Co.	21	32 S.	23 E.	34	Midway
Holly Development Co.	15	32 S.	23 E.	Evans 1	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	26	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	36	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	46	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	54	Midway
Geo. K. Linderman Oil Corp.	22	32 S.	23 E.	1	Midway
Midcrude Petroleum Co.	22	32 S.	23 E.	2	Midway
North American Oil Consolidated	2	32 S.	24 E.	5	Midway
Petrolia Royalties Corp., Ltd.	21	31 S.	22 E.	7	Midway
Quality Oil Co.	22	32 S.	23 E.	Bull 4	Midway
Quality Oil Co.	22	32 S.	23 E.	Bull 5	Midway
Quality Oil Co.	22	32 S.	23 E.	Symington 1	Midway
Quality Oil Co.	27	32 S.	23 E.	W. P. 2	Midway
Quality Oil Co.	27	32 S.	23 E.	W. P. 5	Midway
Richfield Oil Corp.	6	32 S.	23 E.	Fellows 8-A	Midway
Richfield Oil Corp.	6	32 S.	23 E.	Fellows 12	Midway
Shell Oil Co.	22	32 S.	23 E.	McKeon Fee 1	Midway
Shell Oil Co.	22	32 S.	23 E.	McKeon Fee 2	Midway
Standard Oil Co.	23	32 S.	24 E.	39	Midway
Standard Oil Co.	33	32 S.	24 E.	7	Midway
Standard Oil Co.	33	32 S.	24 E.	52	Midway
Standard Oil Co.	33	32 S.	24 E.	79	Midway
Standard Oil Co.	33	32 S.	24 E.	123	Midway
Standard Oil Co.	33	32 S.	24 E.	124	Midway
The Texas Co.	32	32 S.	24 E.	18	Midway
The Texas Co.	32	32 S.	24 E.	19	Midway
Tide Water Associated Oil Co.	35	31 S.	22 E.	31	Midway
Union Oil Co.	22	32 S.	23 E.	Keene 5	Midway
Union Oil Co.	22	32 S.	23 E.	Williams 5	Midway
Valley Oil Co.	18	32 S.	23 E.	Valley 1	Midway
Chevalier Oil Co., Inc.	3	27 S.	28 E.	Southern Pacific 3	Mt. Poso
Ekoh Oil Co.	28	26 S.	28 E.	Vedder 2	Mt. Poso
Recovery Oil Co.	33	26 S.	28 E.	Southern Pacific 2	Mt. Poso
Ring Oil Co., Ltd.	28	26 S.	28 E.	Knapp 2	Mt. Poso
Ring Oil Co., Ltd.	28	26 S.	28 E.	Knapp 3	Mt. Poso
American Exploration Co.	18	30 S.	29 E.	Gilbert 1	Mountain View
Hogan Petroleum Co.	32	30 S.	29 E.	Wharton 8	Mountain View
Hogan Petroleum Co.	4	31 S.	29 E.	Symons-C. C. M. O. 4	Mountain View
Liko Petroleum Corp.	19	30 S.	29 E.	1	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Clendenen 9	Mountain View
Mohawk Petroleum Co.	4	31 S.	29 E.	Earl Fruit Co. 3	Mountain View
Standard Oil Co.	18	30 S.	29 E.	Mabry 4	Mountain View
Trico Oil and Gas Co.	13	30 S.	28 E.	Wilson 2	Mountain View
Vesta Petroleum Co., Ltd.	19	30 S.	29 E.	Vesta 11	Mountain View
Wood-Callahan Oil Co., Ltd.	25	30 S.	28 E.	Wells 3	Mountain View
Bojaki Oil Co.	28	27 S.	27 E.	Bowen 1	Mountain View
Golden Bear Oil Co., Ltd.	32	27 S.	27 E.	Grimes 5	Poso Creek
Golden Bear Oil Co., Ltd.	32	27 S.	27 E.	Grimes 6	Poso Creek
Mines Oil Co.	20	27 S.	27 E.	4	Poso Creek
Pebble Beach Oil Co.	29	27 S.	27 E.	Roscoe-Stanley-New Hope 4	Poso Creek
Roscoe and Stanley	29	27 S.	27 E.	Roscoe-Stanley-New Hope 3	Poso Creek
Standard Oil Co.	9	28 S.	27 E.	3	Poso Creek
Standard Oil Co.	9	28 S.	27 E.	4	Poso Creek
Standard Oil Co.	9	28 S.	27 E.	5	Poso Creek
Standard Oil Co.	9	28 S.	27 E.	6	Poso Creek
California Western Oil Co., Ltd.	12	28 S.	28 E.	2	Round Mountain
California Western Oil Co., Ltd.	7	28 S.	29 E.	21	Round Mountain
California Western Oil Co., Ltd.	7	28 S.	29 E.	22	Round Mountain
Eastmont Oil Co.	16	28 S.	29 E.	Olcese 1	Round Mountain
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	24	Round Mountain
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	25	Round Mountain
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	33	Round Mountain
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	65	Round Mountain
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	87	Round Mountain
Rudolph Pageman and Edward Hennes	10	28 S.	29 E.	Pagehen 1	Round Mountain
Shell Oil Co.	7	28 S.	29 E.	Caldwell 17	Round Mountain
Seaboard Oil Corp.	26	27 S.	24 E.	Seaboard Continental K.C.L. C-1	Semitropic Gas
Alford Oil Co.	25	12 N.	24 W.	Fried 8	Sunset
Berry Holding Co.	34	12 N.	24 W.	Hillside 21	Sunset
L. W. Colby	12	11 N.	24 W.	1	Sunset

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
Five Points Petroleum Corp.	18	11 N.	23 W.	Lease Two 4	Sunset
Hallmark Oil Co.	25	12 N.	24 W.	6	Sunset
The Hancock Oil Co.	8	11 N.	23 W.	Maricopa 5	Sunset
Otis Hoyt	7	11 N.	23 W.	Otis Hoyt Maricopa 5	Sunset
Iroquis Oil Co.	7	11 N.	23 W.	1	Sunset
Merritt Annex Oil Co.	25	12 N.	24 W.	Fried 4	Sunset
Oil Incorporated	7	11 N.	23 W.	O 3	Sunset
Pattiway Oil Corp.	12	11 N.	24 W.	1	Sunset
R. and W. Co.	6	11 N.	23 W.	Francis 4	Sunset
U. S. Pumping Equipment Co.	12	11 N.	24 W.	1	Sunset
Shell Oil Co.	14	30 S.	25 E.	Canal A 21–14	Ten Section
Shell Oil Co.	30	30 S.	26 E.	KCL–A 23–30	Ten Section
Bear Mountain Oil Co.	16	31 S.	30 E.	Tejon 2	----------
Bear Mountain Oil Co.	21	31 S.	30 E.	Tejon 1	----------
Continental Oil Co.	12	29 S.	26 E.	K. C. L. B–1	----------
Doyle Petroleum Corp.	15	25 S.	27 E.	Quinn 2	----------
East Edison Oil Co.	23	30 S.	30 E.	1	----------
P. H. Greer Co., Inc.	9	31 S.	29 E.	Perrel 2	----------
Mohawk Petroleum Co.	23	29 S.	25 E.	K. C. L. 1	----------
The Ohio Oil Co.	32	31 S.	26 E.	Kern County Land Co. A–8	----------
Petroleum Securities Co.	23	29 S.	25 E.	Wright 1	----------
Signal Oil and Gas Co.	21	30 S.	27 E.	K. C. L. A–1	----------
Standard Oil Co.	20	29 S.	26 E.	K. C. 11 2	----------
Standard Oil Co.	20	29 S.	26 E.	K. C. 11 3	----------
Standard Oil Co.	20	29 S.	26 E.	K. C. 11 4	----------
Standard Oil Co.	30	29 S.	26 E.	K. C. 12 1	----------
Standard Oil Co.	4	30 S.	26 E.	K. C. 14 1	----------
Sunset Oil Co.	17	30 S.	28 E.	Sunset Starr 1	----------
Union Oil Co.	34	28 S.	25 E.	Kernco 1–34	----------
KINGS COUNTY:					
Kettleman North Dome Assoc.	34	21 S.	17 E.	2	Kettleman North Dome
Kettleman North Dome Assoc.	34	21 S.	17 E.	63	Kettleman North Dome
Standard Oil Co.	3	22 S.	17 E.	78	Kettleman North Dome
Central California Utilities Corp.	11	23 S.	19 E.	Kettleman-Lakeview 3	----------
Dudley Ridge Development Co.	24	23 S.	20 E.	Josephine 2	----------
Glen G. Stone	25	20 S.	20 E.	Teeter 1	----------
Tri-Counties Oil Co.	10	23 S.	22 E.	Olson 1	----------
LOS ANGELES COUNTY:					
Standard Oil Co.	13	3 S.	11 W.	Emery 62	Coyote Hills
Shell Oil Co.	33	3 S.	13 W.	Reyes 90	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 91	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 54	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 55	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 46	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 47	Dominguez
The Caminol Co., Ltd.	18	3 S.	14 W.	Caminol-El Segundo 2	El Segundo
The Ohio Oil Co.	7	3 S.	14 W.	A. S. Gough 3	El Segundo
Republic Petroleum Co.	18	3 S.	14 W.	Republic El Segundo 5	El Segundo
Republic Petroleum Co.	18	3 S.	14 W.	Republic El Segundo 6	El Segundo
Republic Petroleum Co.	18	3 S.	14 W.	Republic El Segundo 7	El Segundo
Republic Petroleum Co.	18	3 S.	14 W.	Republic El Segundo 8	El Segundo
Richfield Oil Corp.	18	3 S.	14 W.	El Segundo 4	El Segundo
Richfield Oil Corp.	18	3 S.	14 W.	El Segundo 5	El Segundo
Richfield Oil Corp.	18	3 S.	14 W.	Santa Fe 1	El Segundo
Royalty Service Corp., Ltd.	7	3 S.	14 W.	El Segundo 1	El Segundo
The Texas Co.	18	3 S.	14 W.	Security 1	El Segundo
The Texas Co.	18	3 S.	14 W.	Security 2	El Segundo
Union Oil Co.	18	3 S.	14 W.	El Segundo 1	El Segundo
Union Oil Co.	18	3 S.	14 W.	El Segundo 2	El Segundo
Country Club Oil Co.	19	2 S.	14 W.	Country Club 1	Inglewood
Standard Oil Co.	8	2 S.	14 W.	L. A. Investment Lease 82	Inglewood
Standard Oil Co.	8	2 S.	14 W.	L. A. Investment Lease 83	Inglewood
Hilltop Petroleum Co.	29	4 S.	12 W.	Bass & Goodknight 7	Long Beach
The Texas Co.	19	4 S.	12 W.	Harlow Kent 13	Long Beach
Yunker Oil Co., Ltd.	29	4 S.	12 W.	6	Long Beach
The Texas Co.	6	2 S.	11 W.	Baldwin 16	Montebello
The Texas Co.	6	2 S.	11 W.	Baldwin 17	Montebello

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Continued:					
Union Oil Co.	1	2 S.	12 W.	La Merced 26	Montebello
Universal Consolidated Oil Co.	5	2 S.	11 W.	F 1	Montebello
A. G. Burt	36	4 N.	17 W.	1	Newhall
Metropolitan Oil Co.	34	2 S.	15 W.	Metropolitan 1	Palya del Rey
Union Oil Co.	27	2 S.	15 W.	Del Rey 17	Playa del Rey
Union Oil Co.	18	3 S.	13 W.	Rosecrans 16	Rosecrans
Tide Water Associated Oil Co.	11	5 S.	12 W.	Bryant 16	Seal Beach
Calmore Oil Co.	6	4 S.	14 W.	C. O. C. 1	Torrance
Doherty Oil Co.	31	3 S.	14 W.	Doherty 1	Torrance
Leora Oil Co.	31	3 S.	14 W.	Leora 1	Torrance
Swyer Oil Co.	16	4 S.	14 W.	Swyer 1	Torrance
Two and One Oil Co., Ltd.	16	4 S.	14 W.	Two and One 6	Torrance
P. W. Willett	6	4 S.	14 W.	P. W. Willett 1	Torrance
C. W. Partridge & Wm. Chambers	22	2 S.	11 W.	7	Whittier
Bankline Oil Co.	33	4 S.	13 W.	Tutor 1	Wilmington
Bankline Oil Co.	34	4 S.	13 W.	Classification Yards 1	Wilmington
Bankline Oil Co.	34	4 S.	13 W.	Dominguez Harbor Comm. 13	Wilmington
Bankline Oil Co.	34	4 S.	13 W.	Pacific Terminal Comm. 12	Wilmington
Burnoel Petroleum Co.	28	4 S.	13 W.	1	Wilmington
Burnoel Petroleum Co.	33	4 S.	13 W.	960–A 1	Wilmington
Crail Bros., Inc., Ltd.	33	4 S.	13 W.	McCallister 1	Wilmington
D. W. Elliott and Ira A. Marshall	33	4 S.	13 W.	Mouche 1	Wilmington
Gauthier Oil Co.	27	4 S.	13 W.	Classification Yard 2	Wilmington
General Petroleum Corp.	33	4 S.	13 W.	Flint 1	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Ford 1	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Ford 2	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Ford 3	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Ford 4	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Ford 5	Wilmington
General Petroleum Corp.	4	5 S.	13 W.	Patton 2	Wilmington
General Petroleum Corp.	5	5 S.	13 W.	Eubank 2	Wilmington
General Petroleum Corp.	5	5 S.	13 W.	Eubank 4	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–2	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–3	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–4	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–5	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–6	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–7	Wilmington
George F. Getty, Inc.	33	4 S.	13 W.	W–8	Wilmington
Gilmore Oil Co.	4	5 S.	13 W.	1	Wilmington
Godsford Oil Corp.	32	4 S.	13 W.	1	Wilmington
Graham-Loftus Oil Corp.	33	4 S.	13 W.	Lewis 1	Wilmington
F. C. Hall, Inc.	33	4 S.	13 W.	20–7–1	Wilmington
Interstate Investment Corp.	5	5 S.	13 W.	Kibbe 1	Wilmington
A. T. Jergins Trust	34	4 S.	13 W.	1	Wilmington
A. T. Jergins Trust	34	4 S.	13 W.	2	Wilmington
A. T. Jergins Trust	34	4 S.	13 W.	3	Wilmington
A. T. Jergins Trust	34	4 S.	13 W.	7	Wilmington
A. T. Jergins Trust	34	4 S.	13 W.	8	Wilmington
Las Vegas Land and Water Co.	4	5 S.	13 W.	Offset Well 1	Wilmington
Pacific Western Oil Corp.	32	4 S.	13 W.	Patton 2	Wilmington
Pacific Western Oil Corp.	33	4 S.	13 W.	Murphy 1	Wilmington
Pacific Western Oil Corp.	33	4 S.	13 W.	Patton 1	Wilmington
Gus Pongratz	33	4 S.	13 W.	Roman Tract Comm. 1	Wilmington
Ring Oil Co., Ltd.	5	5 S.	13 W.	Wilmington 1	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	22–7–1	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Banning 21–5–1	Wilmington
Royal Service Corp., Ltd.	33	4 S.	13 W.	Banning 21–5–2	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Buckley 1	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Community 4	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Gilmore 17–5–1	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Gilmore 842–1	Wilmington
Royalty Service Corp., Ltd.	33	4 S.	13 W.	Nelson 2	Wilmington
Royalty Service Corp., Ltd.	4	5 S.	13 W.	Nelson 1	Wilmington
Royalty Service Corp., Ltd.	5	5 S.	13 W.	Community 2	Wilmington
Royalty Service Corp., Ltd.	5	5 S.	13 W.	Community 3	Wilmington
Slegna Associates, Inc.	33	4 S.	13 W.	Silveria-Larquier 1	Wilmington
Sovereign Oil Corp.	33	4 S.	13 W.	3	Wilmington
Sunrise Oil Co.	28	4 S.	13 W.	1	Wilmington
Union Pacific Railroad Co.	33	4 S.	13 W.	Union Pac fic Offset Well	Wilmington
Union Pacific Railroad Co.	33	4 S.	13 W.	Union Pacific Offset Well 6	Wilmington

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
Union Pacific Railroad Co.	33	4 S.	13 W.	Union Pacific Offset Well 9	Wilmington
Union Pacific Railroad Co.	34	4 S.	13 W.	Union Pacific Offset Well 15	Wilmington
Union Pacific Railroad Co.	34	4 S.	13 W.	Union Pacific Offset Well 16	Wilmington
Union Pacific Railroad Co.	34	4 S.	13 W.	Union Pacific Offset Well 21	Wilmington
Union Pacific Railroad Co.	34	4 S.	13 W.	Union Pacific Offset Well 22	Wilmington
Union Pacific Railroad Co.	3	5 S.	13 W.	Union Pacific Offset Well 10	Wilmington
Union Pacific Railroad Co.	3	5 S.	13 W.	Union Pacific Offset Well 14	Wilmington
Union Pacific Railroad Co.	3	5 S.	13 W.	Union Pacific Offset Well 19	Wilmington
Union Pacific Railroad Co.	3	5 S.	13 W.	Union Pacific Offset Well 20	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 1	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 2	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 3	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 5	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 7	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 11	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 12	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 13	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 17	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 18	Wilmington
Union Pacific Railroad Co.	4	5 S.	13 W.	Union Pacific Offset Well 23	Wilmington
Western States Drilling Co.	33	4 S.	13 W.	W-2	Wilmington
V. R. G. Wilbur	28	4 S.	13 W.	Wilmington Comm. 1	Wilmington
V. R. G. Wilbur	33	4 S.	13 W.	Mutual 1	Wilmington
Wilmington Oil and Development Co.	33	4 S.	13 W.	Community 1	Wilmington
Wilmington Oil and Development Co.	33	4 S.	13 W.	W-3	Wilmington
Caltana Corp.	11	4 S.	12 W.	Caltana 1	----------
Hogan Petroleum Co.	23	3 S.	11 W.	McNally 1	----------
Eugene C. McClaran	27	4 S.	14 W.	1	----------
ORANGE COUNTY:					
Bandini Petroleum Co.	24	3 S.	10 W.	Bowen 1	Coyote Hills
Dolicia Oil Co.	24	3 S.	10 W.	Anaheim-Union 2	Coyote Hills
Standard Oil Co.	24	3 S.	11 W.	Emery 63	Coyote Hills
Holly Oil Co.	35	5 S.	11 W.	7A	Huntington Beach
W. E. McCaslin	2	6 S.	11 W.	2	Huntington Beach
The Petroleum Co.	2	6 S.	11 W.	Wilson 5	Huntington Beach
Re-Mine Oil Co.	34	5 S.	11 W.	Humble 2	Huntington Beach
Richrow Corp.	10	6 S.	11 W.	Severns 1-A	Huntington Beach
The Texas Co.	11	6 S.	11 W.	Brown 8	Huntington Beach
Tide Water Associated Oil Co.	2	6 S.	11 W.	Miley-Keck 55	Huntington Beach
Union Oil Co.	34	5 S.	11 W.	Copeland 9	Huntington Beach
Union Oil Co.	34	5 S.	11 W.	Copeland 10	Huntington Beach
Union Oil Co.	34	5 S.	11 W.	Copeland 24	Huntington Beach
West American Oil Co.	34	5 S.	11 W.	W. A. 14	Huntington Beach
A. H. Joseph	29	3 S.	9 W.	Joseph-Wagner 1	Richfield
Principal Oil Corp.	36	3 S.	9 W.	1	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 43	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 44	Richfield
Union Oil Co.	29	3 S.	9 W.	Chapman 45	Richfield
Union Oil Co.	29	3 S.	9 W.	Coyle 8	Richfield
Shell Oil Co.	23	4 S.	10 W.	1	----------
SAN JOAQUIN COUNTY:					
Coast Exploration Co.	2	3 S.	4 E.	TF 1-1	----------
Standard Oil Co.	24	2 N.	4 E.	McDonald Island Farms 3	----------
SAN LUIS OBISPO COUNTY:					
Burkholder Oil Corp.	14	10 N.	26 W.	Clay 1	----------
Gretna Corp.	24	30 S.	10 E.	Maino-Gonzales 1	----------

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
SANTA BARBARA COUNTY:					
General Petroleum Corp.	32	5 N.	30 W.	Erburu 17	Capitan
General Petroleum Corp.	32	5 N.	30 W.	Erburu 18	Capitan
Shell Oil Co.	32	5 N.	30 W.	Covarrubias 1 20	Capitan
Shell Oil Co.	32	5 N.	30 W.	Covarrubias 1 23	Capitan
Barnsdall Oil Co.	9	8 N.	32 W.	Tognazzini 6	Cat Canyon
Barnsdall Oil Co.	9	8 N.	32 W.	Tognazzini 8	Cat Canyon
Barnsdall Oil Co.	9	8 N.	32 W.	Tognazzini 9	Cat Canyon
Moyle Petroleum Co.	4	8 N.	32 W.	Arata 1	Cat Canyon
The Petrol Corp.	9	8 N.	32 W.	Tognazzini 3–A	Cat Canyon
Stewart Carter Oil Co.	4	8 N.	32 W.	Burton 1	Cat Canyon
Union Oil Co.	26	9 N.	34 W.	Squires 17	Santa Maria
Union Oil Co.	26	9 N.	34 W.	Squires 18	Santa Maria
R. R. Bush Oil Co.	30	10 N.	33 W.	Hancock-Bush, Hopkins 1	Santa Maria Valley
Gunnar Eriksson	16	10 N.	34 W.	Dart 1	Santa Maria Valley
Union Oil Co.	30	10 N.	33 W.	Cook 1	Santa Maria Valley
Union Oil Co.	30	10 N.	33 W.	Vincent 2	Santa Maria Valley
Union Oil Co.	21	10 N.	34 W.	O'Donnell 1	Santa Maria Valley
Union Oil Co.	23	10 N.	34 W.	Enos 3–23	Santa Maria Valley
Union Oil Co.	24	10 N.	34 W.	Mahoney 3	Santa Maria Valley
SOLANO COUNTY:					
Amerada Petroleum Corp.	25	4 N.	2 E.	Drouin 2	----------
Amerada Petroleum Corp.	26	4 N.	2 E.	Drouin 1	----------
Amerada Petroleum Corp.	35	4 N.	2 E.	Mayhood 1	----------
TEHAMA COUNTY:					
E. F. Stella, Trustee	30	23 N.	3 W.	Johnson 2	----------
VENTURA COUNTY:					
Calumet Oil Co.	3	3 N.	19 W.	16	Bardsdale
The Texas Co.	4	3 N.	19 W.	Shiells 132	Bardsdale
Union Oil Co.	12	3 N.	20 W.	Robertson 16	Bardsdale
Giovanni Vai	4	4 N.	21 W.	Scott 1	Ojai
Pacific Western Oil Corp.	4	4 N.	18 W.	Temescal 10	Piru
C. C. M. O. Co.	8	3 N.	24 W.	Hobson B–13	Rincon
C. C. M. O. Co.	15	3 N.	24 W.	Hobson A–5	Rincon
Continental Oil Co.	15	3 N.	24 W.	Hobson 3	Rincon
Frank E. Arnett	15	4 N.	21 W.	Arnett 3	Santa Paula
H. A. Ivers	1	4 N.	20 W.	14	Sespe
Shell Oil Co.	21	3 N.	23 W.	Taylor 91	Ventura
Tide Water Associated Oil Co.	26	3 N.	23 W.	Lloyd 66	Ventura
Tide Water Associated Oil Co.	26	3 N.	23 W.	Lloyd 137	Ventura
Tide Water Associated Oil Co.	27	3 N.	23 W.	Lloyd 29	Ventura
Tide Water Associated Oil Co.	27	3 N.	23 W.	Lloyd 60	Ventura
Tide Water Associated Oil Co.	27	3 N.	23 W.	Lloyd 64	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

6—44540

NEW PLACER MINING DEBRIS LAW

Governor Merriam approved Senate Bill 310 regulating mining operations in the Trinity and Klamath River Fish and Game District on May 17, 1937. The Act amends Section 482 of the Fish and Game Code, and is numbered Chapter 306 of the Statutes of 1937. It became effective immediately upon approval, as it carried an urgency clause.

The text of the new law follows:

482. (a) It is unlawful to conduct any mining operations in the Trinity and Klamath River fish and game district between July 1 and November 30, both dates inclusive, except when the debris, substances, tailings or other effluent from such operations do not and can not pass into the waters in said district.

(b) It is unlawful between July 1 and November 30, both dates inclusive, to pollute, muddy, contaminate, or roil the waters of the Trinity and Klamath River fish and game district. It is unlawful between said dates to deposit in or cause, suffer, or procure to be deposited in, permit to pass into or place where it can pass into said waters, any debris, substance or tailings from hydraulic, placer, milling or other mining operation affecting the clarity of said waters. The clarity of said waters shall be deemed affected when said waters at a point a distance of one mile below the confluence of the Klamath River and the Salmon River or at a point a distance of one mile below the confluence of the South Fork of the Trinity River and the Trinity River contain fifty (50) parts per million, by weight, of suspended matter, not including the natural turbidity of said river or rivers.

(c) It is unlawful, between July 1 and November 30, both dates inclusive, to carry on or operate any hydraulic mine of any kind on, along, or in any waters flowing into said Trinity and Klamath River district, provided, however, nothing herein contained shall prevent the operation of a hydraulic mine where the tailings, substance, or debris, or other effluent therefrom, does not or will not pass into said waters of said Trinity and Klamath River fish and game district, between said dates, and provided further that any person, firm or corporation engaged in hydraulic mining shall have the right until the fifteenth day of July to use water for the purpose of cleaning up.

(d) Any structure or contrivance which causes or contributes, in whole or in part, to the condition, the causing of which is in this section prohibited, is a public nuisance, and any person, firm or corporation maintaining or permitting the same shall be guilty of maintaining a public nuisance, and it shall be the duty of the district attorney of the county where the condition occurs or the acts creating the public nuisance occur, to bring action to abate such public nuisance.

(e) Any person, firm, or corporation violating any of the provisions of this section is guilty of a misdemeanor.

SEC. 2. This act is hereby declared to be an urgency measure necessary for the immediate preservation of public peace, health and safety within the meaning of section 1 of Article IV of the Constitution of this State. A statement of the facts constituting such necessity is as follows:

The streams guarded against pollution by this act constitute an extensive recreation district and the preservation of the mining industry is vital to the State of California and in order that the health of visitors be protected and recreation facilities protected during the summer months of this year it is necessary that this act take immediate effect.

ADMINISTRATIVE

Personnel.

There have been no changes of personnel in the Division of Mines to be noted the past three months.

New Publications.

'CALIFORNIA JOURNAL OF MINES AND GEOLOGY,' October, 1936, being Chapter 4 of the State Mineralogist's Report XXXII. This chapter contains: 'Mineral Resources of Lassen County'; 'Mineral Resources of Modoc County'; 'Mechanics of the Lone Mountain Landslides, San Francisco'; and the following special articles:

'Biennial Report of the State Mineralogist'; 'Properties and Industrial Applications of Opaline Silica.'

'CALIFORNIA JOURNAL OF MINES AND GEOLOGY,' January, 1937, being Chapter 1 of the State Mineralogist's Report XXXIII. This chapter contains: 'Source Data of the Geologic Map of California, January, 1937'; 'The Geology of Quicksilver Ore Deposits'; 'Prospecting for Lode Gold.'

COMMERCIAL MINERAL NOTES (Nos. 166–168 inc.) February, March, April, 1937, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'CALIFORNIA JOURNAL OF MINES AND GEOLOGY.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

The counties of California have produced for some years past more than 50 different mineral substances, the total value of which was estimated at $300,557,000 for 1936. See January, 1937, issue of California Journal of Mines and Geology.

At present (April, 1937) reports for most of the producers are in hand. Data for several substances are now complete and have been compiled, being presented herein. Information at hand indicates that there was no commercial production during 1935 of the following: antimony, arsenic, asbestos, bismuth, fluorspar, graphite, lepidolite, molybdenum ore, serpentine, shale oil, strontium, tin, titanium, and wollastonite.

There was a single producer, each, of the following: bromine, calcium chloride, carbon dioxide, iodine, magnesite, mineral paint, potash, pyrite, and sulphur.

BORATES

During 1936 there was produced in California a total of 319,658 tons of borate materials compared with 263,915 tons for the year 1935. The material shipped during the year included the new sodium borates, kernite (rasorite), kramerite from Kern County; also crystallized borax prepared by evaporation of brines at Searles Lake in San Bernardino County and Owens Lake in Inyo County.

As the crude ore is not sold as such, but is almost entirely calcined before shipping to the refinery for conversion into the borax of commerce, and because of the fact that the material varied widely in boric acid content, we have recalculated the tonnage to a basis of 40 per cent. A. B. A. This is approximately the average A. B. A. content of the colemanite material after calcining, and also of the crystallized borax obtained from evaporation of the lake brines.

Recalculated as above, the 1936 production totaled 313,389 short tons valued at $5,911,093. This was an increase both in quantity and value over the 1935 output, which was 280,249 tons worth $4,602,064.

The total amount of borates exported from the United States[1] during the year 1936 was 102,021 tons valued at $3,119,850 as compared with 114,447 tons worth $3,242,350 in 1935.

[1] Monthly Summary of Foreign Commerce of the United States, Department of Commerce, Dec. 1936, Part 1.

COAL

The coal produced in California during 1936 amounted to 370 tons valued at $1,815, as compared with 8049 tons worth $32,745 in 1935. The material in 1936 came from a single property each in Amador, San Benito, and Trinity counties. This coal was consumed by the local market and also used on the property for camp purposes, power and forge, to carry on regular operations and development work.

CEMENT

During 1936 there was a production of 13,300,188 barrels of cement in California, valued at $18,314,589 f.o.b. plant, of which 4,394,082 barrels came from northern California plants and 8,906,106 barrels came from southern California plants. The 1936 output was an increase over that of 1935 which was 8,086,292 barrels worth $10,120,721.

Shipments during 1936 were made from ten plants in nine counties to the extent of 12,994,393 barrels valued at $18,090,256, as compared with 8,167,595 worth $11,065,516. There were in operation during the year, five plants in northern California, one each in Calaveras, Contra Costa, Merced, San Mateo, Santa Cruz counties, which shipped 4,283,698 barrels of cement; and five plants in southern California, two in San Bernardino County, and one each in Kern, Los Angeles [1] and Riverside counties, which shipped 8,710,695 barrels of cement. There were 2168 men employed in the above plants during the year 1936.

GYPSUM

During 1936 there were shipments of gypsum in California amounting to 143,549 tons valued at $282,703, coming from three properties in Fresno County, and one each in Imperial, Kern, and Riverside counties. This was an increase in both amount and value over the 1935 output which was 70,833 tons worth $151,807.

MAGNESIUM SALTS

During 1936 there was an output of magnesium salts in California coming from one plant in San Diego County and two plants in San Mateo County, amounting to 3798 short tons valued at $347,838 and consisted of the chloride and carbonate. The 1936 production was an increase in both amount and value over that of 1935 which was 2785 tons worth $235,531. This was the chloride and the carbonate. The chloride was nearly all sold for use in magnesite stucco and cement mixtures (Sorel cement), also some for road liquor. The carbonate, a bulky white powder, was used as a heat-insulating material, as a filler for rubber, paper, paint, etc., and in medicines, in tooth paste, in face powder and as a polish for metal and glass. The sulphate marketed was utilized for medicinal and bath purposes. The material coming from San Diego County was residual bitterns from the salt plants and was in part marketed in the liquid form carrying from 35 per cent to 67 per cent $MgCl_2$ and in part as dry crystals, while that from San Mateo County was magnesium carbonate.

The average value reported for the chloride produced in California in 1936 was approximately $29.16 per ton, f.o.b. plant.

[1] The plant in Los Angeles County grinds clinker coming from other counties, therefore the crude material is credited to the point of origin.

QUICKSILVER

The production of quicksilver in California during the year 1936 was 8758 flasks valued at $671,055, compared with the 1935 output of 9353 flasks worth $628,590. Distribution of the 1936 output was as follows:

County	*Flasks*	*Value*
Lake	3795	$292,571
Napa	737	55,556
San Benito	640	50,271
San Luis Obispo	2588	196,786
Santa Clara	166	11,581
Sonoma	182	14,081
Colusa, Contra Costa, Fresno, Inyo, Kern, Monterey, Santa Barbara, Solano, Trinity, Yolo *	650	50,209
Totals	8758	$671,055

* Combined to conceal the output of individual operators.

SALT

During 1936 there was an output in California of 398,249 short tons of salt worth $1,227,505 compared with 365,711 tons worth $1,230,-480 in 1935. There were eleven companies operating plants in 1936—two in San Bernardino County and one each in Alameda, Imperial, Kern, Los Angeles, Modoc, Monterey, Orange, San Diego, and San Mateo.

The average value reported for salt produced in California during 1936 was $3.08 per ton f.o.b. plant, compared with $3.36 in 1935; $3.68 in 1934; $3.89 in 1933; and $3.58 in 1932.

Most of the salt production in California is obtained by evaporation of water of the Pacific Ocean, plants being located on the shores of San Francisco, Monterey, and San Diego bays, and at Long Beach. Additional amounts are derived from lakes and lake beds in the desert regions (in part, rock salt), mainly in Inyo, Kern, and San Bernardino counties, and evaporation of alkaline lake water in Modoc County. A small amount of valuable medicinal salts has been obtained by evaporation of the water of Lake Mono, Mono County.

SILICA (Sand and Quartz)

We combine these materials because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

We do not include under this heading such forms of silica as: quartzite, sandstone, flint, tripoli, diatomaceous earth, nor the gem forms of 'rock crystal,' amethyst, and opal. Each of these has various industrial uses, which are treated under their own designations.

The production of silica in California during 1936 amounted to 77,830 short tons valued at $310,278 f.o.b. rail shipping point, and came from two properties in Contra Costa County and one each in Fresno, Placer, Riverside, and San Diego counties. The above was an increase in both amount and value over the output of 1935, which was 70,835

tons worth $297,272. The 1936 output consisted of 76,571 tons of glass sand and 1259 tons of vein or boulder quartz.

The glass sand came from Contra Costa and Riverside counties. For making the higher grades of glass, deposits in Contra Costa County are replacing the sand imported from Belgium. Belgium sand has displaced local material in the manufacture of sodium silicate ('water glass'). There are various deposits of quartz in California which could be utilized for glass making, but to date they have not been so used owing to the cost of grinding and the difficulty of preventing contamination by iron while grinding.

Silica sand has been produced in the following counties of the State: Alameda, Amador, Contra Costa, El Dorado, Imperial, Inyo, Los Angeles, Mariposa, Mono, Monterey, Orange, Placer, Riverside, San Diego, San Joaquin and Tulare, the chief centers being Contra Costa, Amador, Monterey and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class colorless glass; for such, it must be essentially iron-free. Even a fractional per cent of iron imparts a green color to the glass.

The Tariff Act of June 21, 1930, placed a duty on sand, containing 95 per cent or more of *Silica* and not more than six-tenths of 1 per cent of oxide of iron and suitable for use in the manufacture of glass, of $2 per ton.

SLATE

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, but since then it has been irregular. Large deposits of excellent quality are known in the State, especially in El Dorado, Calaveras and Mariposa counties, but the demand has been light owing principally to competition of cheaper roofing materials.

The production of slate in California during 1936 amounted to 12,252 short tons and 65 squares having a total value of $49,818 f.o.b. quarry and came from properties in Calaveras, El Dorado, Los Angeles, Inyo, and Tuolumne counties. The 1936 figures showed an increase in both amount and value over those of 1935 which were 8066 tons and 40 squares having a total value of $40,912. Practically all the slate was crushed and used for roofing granules. The slate shingles came from Calaveras County, and that from Los Angeles County was sold as flagstone.

SOAPSTONE AND TALC

The total output of talc and soapstone in California during 1936 amounted to 25,643 short tons valued at $309,287. This was an increase in both quantity and value over the 1935 figures, which were 17,332 tons and $170,830. Of the 1936 production, 23,475 tons were high-grade talc from Inyo and San Bernardino counties, which material was utilized mainly in toilet powders, paint, paper, and rubber manufacture, and some in ceramics. The remainder of 2168 tons was soapstone and came from Butte, El Dorado and Los Angeles counties.

The 'soapstone' grades were used mainly for roofing granules and as a filler in roofing paper and part also in magnesite cement.

It is reported that California talc has replaced to some extent imported talc in the toilet trade on the basis of quality. The largest production of talc in the United States comes from Vermont and New York and of massive soapstone from Virginia.

During 1936 imports of talc steatite etc., totaled 24,520 short tons valued at $456,667, as compared with 23,897 tons worth $492,274 during 1935, according to the United States Bureau of Foreign and Domestic Commerce.

The Tariff Act of 1930 places a duty on talc, steatite or soapstone and French chalk, crude or unground, of one-fourth of one cent per pound.

SODA

The production of sodium salts in California in 1936 included: Soda ash, trona, caustic soda, and bicarbonate from plants at Owens Lake, Inyo County; and soda ash, salt cake, and trona ('sesqui-carbonate,' a double salt of Na_2CO_3 and $NaHCO_3$) from Searls Lake, San Bernardino County. There were no shipments of salt cake (sulphate) from Carrizo Plains, San Luis Obispo County.

The output for 1936 amounted to 144,314 short tons valued at $1,412,788, as compared with 125,504 tons worth $1,341,045 in 1935.

The dense ash and bicarbonate were used mainly in the manufacture of soap, glass, paper, oil refining, sugar refining, and chemicals; and the trona for metallurgical purposes.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20751 "PERMIAN PYRAMIDS"—DOLOMITE after Halite.
Found between the Permian clay in central Oklahoma.
Exchange.

20752 QUARTZ CRYSTAL CLUSTER.
From Crystal Gold Quartz Mine, Browns Hill Cascade.
Plumas County, California.
Donor: A. P. Linville.

20753 BERYL with SCHEELITE.
From property of Rare Metals Corporation, Humboldt Range.
near Oreana, Pershing County, Nevada.

Donor: O. F. Heizer, Manager, Rare Metals Corp. February, 1937.

20754 BARITE ($BaSO_4$) Barium Sulphate.
From Liscom Hill, Humboldt County, California.
Donor: George M. Nelson. February, 1937.

20755 STEIGERITE, a yellow, hydrous aluminum vanadate—$Al_2O_3.V_2O_5 6.5\ H_2O$ in sandstone with impregnated oxidized vanadium minerals.
From the north wall of Gypsum Valley, San Miguel County, Colorado. February, 1937. (Lab.)

20756 BERYL ($Be_3Al_2Si_6O_{18}$) with Feldspar and Muscovite Mica.
From Humboldt County, Nevada.
Donor: Addison N. Clark.

20757 GOLD (Au) in Quartz.
From Battle Mountain Dist., Landor County, Nevada.
Donor: C. B. Harr. February, 1937.

20758 LAZULITE, a basic phosphate of aluminum, iron, and magnesium, with sericite.
From Lee Mining Dist., Death Valley National Monument, Inyo County, California.
Donor: Death Valley Curly.

20759 PYROPHYLLITE, a hydrous silicate of aluminum (H_2Al_2-Si_4O_{12}).
From Lee Mining District in Death Valley National Monument, Inyo County, California.
Donor: Death Valley Curly. February, 1937.

20760 MYRICKITE (Cinnabar in Chalcedony).
From Beatty Wash, Beatty, Nye County, Nevada.
Donor: Death Valley Curly. February, 1937.

20761 GOLD in Quartz.
From Exposed Treasure Mine, Mojave, Kern County, California.
Donor: Chas. O'Brien. February, 1937.

20762 ORTHOCLASE FELDSPAR ($KAlSi_3O_8$) Silicate of potash and aluminum.
From three miles south of Redrock Canyon, and west of Cinco Service Station, Kern County, California.
Donor: G. F. Kreg. February, 1937.

20763 CHIASTOLITE, a form of Andalusite.
From four miles southwest of Bridgeport, Mariposa County, California.
Donor: G. F. Kreg. February, 1937.

20764 GOLD ORE.
From Chloride Cliff, Inyo County, California. Assayed $76. Mined in 1928.
Donor: George M. Nelson. February, 1937.

20765 AGATE, showing fine banding.
From the shores of Lake Superior, Michigan.
Donor: W. C. Eyles. February, 1937.

20766 KYANITE (Al_2SiO_5) Aluminum silicate. From India.
Donor: Harry R. Wolfe. March, 1937.

20767 SYLVANITE $(Au\ Ag)_2Te$—gold-silver telluride.
From Ingram Mine, Gold Hill Mining District, Boulder County, Colorado.
Donor: David H. Ladd. March, 1937.

20768 CHALCOPYRITE, Crystallized. Assays ½ oz. Au, 20% Cu.
From Heather Mine, Yavapai County, Arizona. 80-ft. level.
Donor: Chas. Elliott. March, 1937.

20769 WULFENITE—Lead Molybdate ($PbMoO_4$).
From Kingman, Arizona.
Donor: Addison N. Clark. March, 1937.

20770 PYROPHYLLITE $Al_2(SiO_3)_4H_2O$.
From three miles northwest of Keeler, Inyo County, California.
Donor: George M. Nelson. March, 1937.

20771 BARITE, Barium Sulphate ($BaSO_4$)
From 8000–9000 ft. elevation, near Rattlesnake Creek on the upper Kern River, Bald Mountain Barite Deposit, Tulare County, California.
Donor: George M. Nelson. March, 1937.

20772 HEDENBERGITE $(CaFe\ (SiO_3)_2$.
From the base of Horse Mountain, at the junction of the McCloud and Pitt rivers near Baird, Shasta County, California.
Donor: John H. Esselink. March, 1937.

20773 LEPIDOLITE — Lithia Mica (yellow) $KLiAl(OH,F)_2Al(SiO_3)_3$.
From the Black Hills, South Dakota.
Donor: W. C. Eyles. April, 1937.

20774 MARCASITE, Iron Sulphide (FeS_2) Crystals.
From Joplin.
Donor: John Melhase. April, 1937.

20775 CALCITE ($CaCO_3$) in Limestone. The amathystine color is probably due to the presence of a slight amount of manganese.
From Kentucky.
Donor: Mrs. Geo. Lightburn. April, 1937.

20776 MINERAL PAINT (Limonite). Average 85% Fe_2O_3.
From Dempsey Ranch, Yuba County, California.
Donor: N. L. Wimmler. April, 1937.

20777 WILKIEITE, a calcium phosphate and silico-sulphate.
From Crestmore, Riverside County, California.
Donor: W. C. Eyles, April, 1937.

20778 MONTECELLITE (brown) with CRESTMOREITE (white) and DIOPSIDE (green) in Blue Calcite.
From Crestmore, Riverside County, California.
Donor: W. C. Eyles. April, 1937.

LABORATORY

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpose of identifying minerals and making qualitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this state department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is sometimes able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector.

LIBRARY

John C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the state are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH ARE OF INTEREST ESPECIALLY TO CALFORNIA MINING

Governmental, National.

U. S. Geological Survey:

Topographic Sheets:

California:

Huron, western part of Fresno Co. and a small part of Kings Co., N.E. of Kettleman Hills.

Kern River—South Fork, Sheets A to G.

Watts—Scale 1 inch = 2000 feet: contour interval, 5 feet.

Professional Papers:

186H Inference about the origin of oil as indicated by the composition of the organic constituents of sediments, by P. D. Trask.

Bulletins:

878 Analysis of rocks and minerals from the laboratory of the U. S. G. S., 1914–1936, tabulated by R. G. Wells.

Water Supply Papers:

789 Surface water supply of the U. S., 1935, part 9, Colorado River Basin.
791 Part 11, Pacific Slope Basins in California.
794 Part 14, Pacific Slope Basins in Oregon and Lower Columbia River Basin.

U. S. Bureau of Mines:

Report of Investigations:

3325 A Study of Oxidation of the Oil in Two Air and Air-Gas-Repressuring Projects, by T. W. Johnson and S. S. Taylor.
3332 Survey of Fuel Consumption at Refineries in 1935, by G. R. Hopkins.
3334 Application of Sand Filters to Oil-Field Brine-Disposal Systems, by Sam S. Taylor and L. F. Christianson.

3328 Progress Reports—Metallurgical Division:

16 Ore-testing Studies;

Ore-Dressing Tests and Their Significance. By W. F. Dietrich, A. L. Engel, and Morris Guggenheim.
The Analysis of Molybdenum, by A. C. Rice and L. A. Yerkes.
Report of Tests, by C. W. Davis and staff, of Ore-Testing Section

3331 Progressive Reports—Metallurgical Division.

14 Annual Report of the Metallurgical Division, Fiscal Year 1936, by R. S. Dean.

3333 Progress Reports—Metallurgical Division.

15 Ore-Dressing Studies.
Use of Wetting Agents in Flotation, by R. S. Dean, J. Bruce Clemmer and S. R. B. Cooke.
Short-Column Hydraulic Elutriator for Subsieve Sizes, by S. R. B. Cooke.

3336 Beneficiation of Spodumene by Decrepitation, by Foster Fraas and Oliver C. Ralston.
3337 Annual Report of the Explosives Division, Fiscal Year, 1936, by Wilbert J. Huff.

Information Circulars:

6920 Quarrying and Crushing Methods and Costs at the Plainville (Conn.) Trap-Rock Quarry of the New Haven Trap Rock Co., New Britain, Conn. By A. L. Worthen.
6921 Mining and Grinding Methods and Costs at the Dennison Sewer Pipe Co. Clay Mine, Dennison, Ohio. By E. J. Lintner.
6924 Bureau of Mines Activities in the Field of Building Materials. By D. M. Banks.
6925 Suggested Methods for the Reduction of Mine Accidents from the Viewpoint of the Safety Engineer. By E. H. Denny.
6926 Open Schedules for Gold and Silver Ores and Concentrates at Western Custom Smelters. By E. D. Gardner and Paul T. Allsmans.
6929 Mining and Grinding Methods and Costs at the Evans Pipe Co. Clay Mine, Uhrichsville, Ohio. By E. J. Lintner.
6931 Mineral Industries Survey of the U. S., Calif. Kern Co., Mojave Dist. The Golden Queen and Other Mines of the Mojave Dist., Calif. By C. E. Julihn and F. W. Horton.
6934 Resumé of work of the Non-Metals Division, Calendar Year, 1936. By Oliver C. Ralston and A. George Stern.
6938 Some Causes of Blow-Outs During Drilling and Means of Prevention, with Special Reference to the Gulf Coast Region. By Chas. B. Carpenter.
6939 Report of Work of the Mining Division, U. S. Bureau of Mines for Calendar Year, 1936, and Program for 1937. By Chas. F. Jackson.

Books:

Elements of Mining, by R. S. Lewis.
Gold Prospecting (Quartz and Placer), by Stephen Jacy.

Mineral Industry, Vol. 44, by G. A. Roush. Describes the Mineral Industry during 1935.

Register of American Manufacturers, Thomas Publishing Co.

Governmental, National.

U. S. Geological Survey:

Bulletins, Water-Supply Papers, Annual Reports, Professional Papers, Circulars, Monographs, Topographic Maps, and Special Publications.

U. S. Bureau of Mines:

Bulletins, Technical Papers, Economic Papers, Reports of Investigations, Information Circulars and Miners' Circulars.

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon Bureau of Mines and Geology, Corvallis.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.

Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.

California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemnologist, London.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nickel Cast Iron News, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Moscow, Idaho.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.

Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.70
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.70
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	1.25
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.60
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.00
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.55
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	$0.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.90
Mines and Mineral Resources of Plumas County, 188 pp., paper	.60
Mines and Mineral Resources of Sierra County, 144 pp., paper	.60
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.00
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.30
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.30
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.30
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.30
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.30
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.30
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.30
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.30
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.35
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.30
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.35
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.30
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.30
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.30
April, 1928, Mines and Mineral Resources of Mariposa County	.30
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.30

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	$0.30
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.35
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.35
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.35
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.35
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.30
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.35
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.35
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.35
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.35
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.30
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.35
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.35
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.65

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

Price Postpaid

Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:

January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties ---------- $0.90

July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543 ---------- .90

Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits ---- .50

April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores ---------- .90

October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas ---------- .50

Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation ---------- .50

April. A Geologic Section Across the Southern Penninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits ---------- .50

July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights ---------- .50

October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County ---------- .50

Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Gold Mines of Placer County, including Drag-line Dredges. Geologic report on Borax Lake, California ---------- .50

April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum .50

July. Mines and Mineral Resources of Calavaras County Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost

REPORTS—Continued

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	Price Postpaid
of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization	$0.50
October. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco Biennial Report of the State Mineralogist, Properties and Industrial Applications of Opaline Silica	.50
Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology' containing the following:	
January. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold	.50
Subscription, $2.00 postpaid in advance (by calendar year, only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----
January, **February, **March, April, **May, **June, **July, August **September, **October, **November, **December, 1921	Free
January, February, March, April, May, June, **July, **August, September, **October, **November, December, 1922	Free
January, February, **March, **April, May, **June, **July, August, September, **October, November, **December, 1923	Free
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January, February, March, April, May, June, July, August, September, October, November, December, 1925	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1926	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1927	Free
January, February, March, April, **May, June, July, August, September, October, **November, **December, 1928	Free
January, February, March, April, May, June, July-August-September, October-November-December, 1929 (Published quarterly beginning July, 1929)	Free
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free
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January, February, March, 1933	Free
April, May, June, 1933	Free
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April-May-June, 1935	Free

BULLETINS

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**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	$0.10
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----
Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	.75
Bulletin No. 10. A bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	.50
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----
Bulletin No. 12. Mineral Production of California, by Counties, for 1896, by Charles G. Yale. Tabulated sheet	.10
**Bulletin No. 13. Mineral Production of California, by Counties, for 1897, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 14., Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----
Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	.10
Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	.10
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, 9 maps	.75
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----
Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	.10
Bulletin No. 26. Mineral Production of California for the Past Fifteen Years, by Charles G. Yale. 102. Tabulated sheet	.10
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----

BULLETINS—Continued

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Bulletin No. 28. Mineral Production of California for 1902, by Charles G. Yale. Tabulated sheet	$0.10
Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	.10
**Bulletin No. 30. Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905. 120 pp., 66 illustrations, 3 maps	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map	----
Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet	.10
Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet	.10
Bulletin No. 41. Mines and Minerals of California for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps	.10
Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	.10
Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet	.10
Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	.10
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.	----
**Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.	----
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 48. Mineral Production of California for Twenty Years, by Charles G. Yale. 1906	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorn and J. A. Edman. 366 pp., 74 illustrations. (Revised edition)	1.25
Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker, Tabulated sheet	.10
Bulletin No. 52. Mineral Production of California for Twenty-one Years, by D. H. Walker, 1907. Tabulated sheet	.10
Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker. 62 pp.	.10
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet	----
Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet	.10
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker, 78 pp.	----

BULLETINS—Continued

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	Price Postpaid
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations, 10 maps	----
Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker. 1909. Tabulated sheet	$0.10
Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker. 1909. Tabulated sheet	.10
**Bulletin No. 60. Mineral Production for 1909, with County Maps and Mining Laws of California, by D. H. Walker. 94 pp.	----
Bulletin No. 61. Mineral Production of California, by Counties, for 1910, by D. H. Walker. Tabulated sheet	.10
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker. 1910. Tabulated sheet	----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps	----
Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.	.15
Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.	.25
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**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp.	----
Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.	.25
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]	----
Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.	.25
Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley, 193 pp. 4 illustrations	.25
**Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.	----
**Reconnaissance Geologic Map (of which Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch=12 miles. Mounted	----
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the Fiscal Year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations	----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations	.25
**Bulletin No. 75. United States and California Mining Laws. 1917, 115 pp., paper	----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring. 1918, 248 pp., 51 illustrations, 5 maps, paper	.60
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880-1917, by E. S. Boalich. 44 pp. paper	Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley. 1919, 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth	1.90
Bulletin No. 79. Magnesite in California, by Walter W. Bradley. 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth	1.10
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†Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)	
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the Fiscal Year 1916-1917, by R. P. McLaughlin. 1918, 412 pp., 31 illustrations, cloth	----
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† Not yet published.

BULLETINS—Continued

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**Bulletin No. 85. Platinum and Allied Metals in California, by C. A. Logan, 1919. 10 photographs, 4 plates, 120 pp., paper	----
Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley. 1919, 212 pp., paper	Free
Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello. 1920, 124 pp., paper	$0.75
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley. 1920, 204 pp., paper	Free
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leck. 1921, 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth	----
Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley. 1921, 218 pp., paper	.25
**Bulletin No. 91. Minerals of California, by Arthur S. Eakle. 1923, 328 pp., cloth	----
**Bulletin No. 92. Gold Placers of California, by Chas. S. Haley. 1923, 167 pp., 36 photographs and 7 plates (colored and line cuts, also geological map), cloth	----
Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley. 1923, 188 pp., paper	.15
Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley. 1924, 162 pp., paper	.25
Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin. 1925, 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth	2.75
Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley. 1925, 173 pp., paper	.15
**Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley. 1926, 172 pp., paper	----
Bulletin No. 98. American Mining Law, by A. H. Ricketts, 1931, 811 pp., flexible leather	3.25
Bulletin No. 99. Clay Resources and Ceramic Industry of California, by Waldemar Fenn Dietrich. 1928, 383 pp., 70 photographs, 12 line cuts including maps, cloth	1.75
Bulletin No. 100. California Mineral Production for 1926, by Walter W. Bradley. 1927, 174 pp., paper	.25
Bulletin No. 101. California Mineral Production for 1927, by Henry H. Symons. 1928, 311 pp., paper	.25
Bulletin No. 102. California Mineral Production for 1928, by Henry H. Symons. 1929, 210 pp., paper	.25
Bulletin No. 103. California Mineral Production for 1929, by Henry H. Symons, 1930. 231 pp., paper	.25
Bulletin No. 104. Bibliography of the Geology and Mineral Resources of California, to the end of 1930, by Solon Shedd	2.25
**Bulletin No. 105. Mineral Production in California for 1930 and Directory of Producers	----
Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25
Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	.50
Bulletin No. 108. Mother Lode Gold Belt of California, by Clarence A. Logan, 1934, 240 pp., with geologic and claim maps, cloth	2.00
Bulletin No. 109. California Mineral Production and Directory of Mineral Producers for 1932, by Henry H. Symons, 200 pp., paper	.25
Bulletin No. 110. California Mineral Production and Directory of Mineral Producers for 1933, by Henry H. Symons, 214 pp., paper	.25
Bulletin No. 111. California Mineral Production and Directory of Mineral Producers for 1934, by Henry H. Symons, 334 pp., paper	.75

PRELIMINARY REPORTS

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	Price Postpaid
**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin, 4 pp.	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin, 4 pp.	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.	$0.05
**Preliminary Report No. 4. Tungsten, Molydbdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper	----
**Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W .O. Castello, 1918. 44 pp. Paper	----
Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton, 1920. 43 pp. Paper	.05
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	----

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper	----
Bulletin. Reconnaisance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper	.10
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 (15c annually)	Free
**Register of Mines, with Map, Amador County	----
Register of Mines, with Map, Butte County	.30
**Register of Mines, with Map, Calaveras County	----
**Register of Mines, with Map, El Dorado County	----
**Register of Mines, with Map, Inyo County	----
**Register of Mines, with Map, Kern County	----
**Register of Mines, with Map, Lake County	----
**Register of Mines, with Map, Mariposa County	----
Register of Mines, with Map, Nevada County	.30
**Register of Mines, with Map, Placer County	----
**Register of Mines, with Map, Plumas County	----
**Register of Mines, with Map, San Bernardino County	----
Register of Mines, with Map, San Diego County	.30
Register of Mines, with Map, Santa Barbara County (1906)	.30

MAPS

Register of Mines With Maps

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Register of Mines, with Map, Shasta County	----
**Register of Mines, with Map, Sierra County	----
**Register of Mines, with Map, Siskiyou County	----
**Register of Mines, with Map, Trinity County	----
**Register of Mines, with Map, Tuolumne County	----
Register of Mines, with Map, Yuba County (1905)	$0.30
Register of Oil Wells, with Map, Los Angeles City (1906)	.10

OTHER MAPS

**Map of California, Showing Mineral Deposits (50x60 in.)	----
**Map of Forest Reserves in California	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
**Map of Madera County, Showing Boundaries, National Forests	----
**Map of Placer County, Showing Boundaries, National Forests	----
**Map of Shasta County, Showing Boundaries, National Forests	----
**Map of Sierra County, Showing Boundaries, National Forests	----
**Map of Siskiyou County, Showing Boundaries, National Forests	----
**Map of Tuolumne County, Showing Boundaries, National Forests	----
**Map of Mother Lode Region	----
**Map of Desert Region of Southern California	----
Map of Minaret District, Madera County	.25
Map of Copper Deposits in California	.05
**Map of Calaveras County	----
**Map of Plumas County	----
**Map of Trinity County	----
**Map of Tuolumne County	----
Geographical Map of Inyo County. Scale 1 inch equals 4 miles	.65
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	----
Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted	2.75
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92. In 4 colors (also sold singly)	----
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt, accompanying July-October Chapter of Report XXVIII of the State Mineralogist. (Sold singly)	.25
Map of Northern California, showing rivers and creeks which produced placer gold in 1932	.20
Mother Lode Geologic and claim maps in 5 county sections: El Dorado, Amador, Calaveras, Tuolumne and Mariposa. Single sections 10c. Set of 5	.50
Map of Mariposa County, showing principal gold mines	.10
Geologic Map of Elizabeth Lake Quadrangle, Los Angeles and Kern Counties (accompanying October Chapter of Report XXX), sold separately	.10
Map of Western Portion of Siskiyou County Showing Location of Principal Gold Mines (accompanying July Chapter of Report XXXI), sold separately	.10
Geologic Map of Redding and Weaverville Quadrangles Showing Location of Gold Mines	.25
Map of Ancient Channel System, Calaveras County	.10
Map of Ancient Channels Between San Andreas and Mokelumne Hill	.10

OIL FIELD MAPS

The maps are revised from time to time as development work advances and ownerships change.

	Price (including postage)
Map No. 1—Sargent, Santa Clara County	$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	1.00
Map No. 3—Santa Maria, including Casmalia and Lompoc	1.00
Map No. 4—Brea Olinda & (East Portion) Coyote Hills, Los Angeles and Orange Counties	1.00
Map No. 6—Salt Lake-Beverly Hills, Los Angeles County	1.00
Map No. 7—Sunset and San Emidio, Kern County	1.00
Map No. 8—South Midway and Buena Vista Hills, Kern County	1.00
Map No. 9—North Midway and McKittrick, Kern County	1.00
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Map No. 11—Lost Hills and North Belridge, Kern County	1.00
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Map No. 13—Kern River, Kern County	1.00
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Map No. 20—Long Beach, Los Angeles County	1.50
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Map No. 21-A—Portion of District No. 4, showing boundaries of oil fields—Kern County	.75
Map No. 21-B—Portion of District No. 5, showing boundaries of oil fields—Fresno, Kings and Kern Counties	.75
Map No. 22—Portion of District No. 3, showing boundaries of oil fields—Santa Barbara County	.75
Map No. 23—Portion of District No. 2, showing boundaries of oil fields—Ventura County	.75
Map No. 24—Portion of District No. 1, showing boundaries of oil fields—Los Angeles and Orange Counties	1.00
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Map No. 29—Dominguez, Los Angeles County	.75
Map No. 30—Rosecrans, Los Angeles County	.75
Map No. 31—Inglewood, Los Angeles County	1.00
Map No. 32—Seal Beach, Los Angeles and Orange Counties	1.00
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Map No. 34—Mt. Poso, Kern County	.75
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Map No. 37—Montebello, Los Angeles County	1.00
Map No. 38—Whittier, Los Angeles County	1.00
Map No. 39—West Coyote, Los Angeles and Orange Counties	1.00
Map No. 40—Elwood, Santa Barbara County	1.00
Map No. 41—Potrero, Los Angeles County	.75
Map No. 42—Playa del Rey, Los Angeles County	1.25
Map No. 43—Capitan, Santa Barbara County	.75
Map No. 44—Mesa, Santa Barbara County	1.25
Map No. 45—Buttonwillow gas, Kern County	.75
Map No. 46—Richfield, Orange County	1.00
Map No. 47—Mountain View, Kern County	.75
Map No. 48—Mountain View and Edison, Kern County	1.25
Map No. 49—Fruitvale, Kern County	.75
Map No. 50—Wilmington, Los Angeles County	1.00
Map No. 51—Santa Maria Valley, Santa Barbara County	.75
Map No. 52—El Segundo and Lawndale, Los Angeles County	1.00
Map No. 53—Greeley and Ten Section, Kern County	.75

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIII

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
CALIFORNIA

48055

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State Mineralogist

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·STATE·OF·CALIFORNIA·
·DEPARTMENT·OF·NATURAL·RESOURCES·
·GEORGE D. NORDENHOLT - DIRECTOR·
·DIVISION·OF·MINES·
·WALTER W. BRADLEY·
·STATE MINERALOGIST·
OUTLINE MAP
OF
CALIFORNIA
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SISKIYOU
MODOC
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
NEVADA
LAKE
COLUSA
YUBA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
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SOLANO
CALAVERAS
MONO
MARIN
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SAN JOAQUIN
TUOLUMNE
SAN FRANCISCO
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SAN MATEO
SANTA CLARA
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MADERA
FRESNO
INYO
SAN BENITO
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TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
PACIFIC OCEAN
NEVADA
MEXICO
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geological Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to California Journal of Mines and Geology, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).

3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District on account of unfinished field work.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field Division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

MINERAL RESOURCES OF LOS ANGELES COUNTY

By R. J. SAMPSON, Mining Engineer

Los Angeles County, which has the largest population of any county in the State, is located well toward the southern end of the State and is bounded on the north by Kern County, on the east by San Ber-

nardino County, on the south by Orange County and on the west by the Pacific Ocean. Its population is approximately 2,750,000 and it contains 4067 square miles.

Topography

There are three mountain ranges in the county: The San Gabriel, Santa Susana and Santa Monica Mountains. These are separated from the ocean by the broad, flat Los Angeles Plain.

The Santa Monica Mountains extend from the ocean in Ventura County eastward to Los Angeles River. They consist largely of Tertiary sedimentaries. The Santa Susana range lying north of San Fernando valley is the western extension of the San Gabriel, the principal range of the county. The San Gabriel range, consisting of a granitic core flanked by gneisses and schists, extends from Cajon Pass to Soledad Canyon. Elevations range from 5650 ft. on Mt. Lowe to 10,080 ft. on San Antonio (Old Baldy). North Baldy some 8 miles northwest of San Antonio reaches an elevation of 9389 ft.

Two principal rivers flow through the county, the San Gabriel and the Los Angeles. San Gabriel River rises in the San Gabriel mountains, flows southwest, emptying into the ocean at Alamitos bay. Los Angeles River has its source in the Santa Monica Mountains, near the Ventura county line. It flows east and south through the San Fernando Valley uniting with the Rio Hondo near Compton and empties into Long Beach Harbor.

Mineral Resources

The metal production of Los Angeles County is small, its principal mineral resource being petroleum. The production of petroleum in the year 1935 was 70,378,196 barrels, valued at $64,339,261; natural gas production was valued at $4,448,950. The total production through 1935 had amounted to 1,548,294,673 barrels having a value of $1,801,740,157, natural gas $115,399,230.

Following is a list of the principal minerals which have been produced in the county: Asphalt, barytes, borax, brick, clay, copper, diatomite or diatomaceous earth, gems, gold, gypsum, lead, limestone, marble, mineral paint, mineral water, natural gas, petroleum, glass sand, sandstone, serpentine, silver, soapstone, miscellaneous stone and zinc.

In the following pages the minerals are divided into metallic and nonmetallic, the mines of each division being described in alphabetical order.

Metals

ANTIMONY

While no production of this metal has been recorded from Los Angeles County, it does occur associated with complex sulphide ores of copper, cobalt, nickel, lead and zinc in Pacoima Canyon. It is also reported to occur near Lancaster.

Bibl: State Mineralogist's Reports XVII, p. 318; XXIII, p. 288; State Mining Bureau Bull. 38, p. 359.

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Two principal rivers flow through the county, the San Gabriel and the Los Angeles. San Gabriel River rises in the San Gabriel mountains, flows southwest, emptying into the ocean at Alamitos bay. Los Angeles River has its source in the Santa Monica Mountains, near the Ventura county line. It flows east and south through the San Fernando Valley uniting with the Rio Hondo near Compton and empties into Long Beach Harbor.

Mineral Resources

The metal production of Los Angeles County is small, its principal mineral resource being petroleum. The production of petroleum in the year 1935 was 70,378,196 barrels, valued at $64,339,261; natural gas production was valued at $4,448,950. The total production through 1935 had amounted to 1,548,294,673 barrels having a value of $1,801,740,157, natural gas $115,399,230.

Following is a list of the principal minerals which have been produced in the county: Asphalt, barytes, borax, brick, clay, copper, diatomite or diatomaceous earth, gems, gold, gypsum, lead, limestone, marble, mineral paint, mineral water, natural gas, petroleum, glass sand, sandstone, serpentine, silver, soapstone, miscellaneous stone and zinc.

In the following pages the minerals are divided into metallic and nonmetallic, the mines of each division being described in alphabetical order.

Metals

ANTIMONY

While no production of this metal has been recorded from Los Angeles County, it does occur associated with complex sulphide ores of copper, cobalt, nickel, lead and zinc in Pacoima Canyon. It is also reported to occur near Lancaster.

Bibl: State Mineralogist's Reports XVII, p. 318; XXIII, p. 288; State Mining Bureau Bull. 38, p. 359.

1—ALEXANDER ET AL
2—ATLANTA ET AL
3—BAKER & AUSTIN PLACER
4—BEAR CANYON PLACER
5—BIG CHIEF
6—BIG HORN No. 4 LODE ET AL
7—BLACK JACK ET AL
8—BORATE CONSOLIDATED
9—BOWER'S MINE
10—BUEL & FORD PLACER
11—CRUZAN PLACER
12—CRUZAN PLACER
13—DAISY ET AL
14—DEL NORTE ET AL
15—EAGLE GOLD MINE
16—EAGL & LAST CHANCE
17—ELIZABETH PLACER
18—EMPIRE PLACER
19—EMMED PLACER ET AL
20—ENTERPRISE ET AL
21—FERGUSON PLACER
22—FLISHMEYER MINE
23—GEORGE GRAPHITE ET AL
24—GLEN MARIE Nos. 1, 2, 3 LODE
25—GOLD QUEEN
26—GOVERNOR QUARTZ
27—GRAHAM & CECIL
28—HORSESHOE CONS. PLACER
29—JUSTICE PLACER
30—KAOLIN & MANZANITA

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31—KATAHDIN & ONTARIO
32—KELSEY ET AL
33—LAP WING ET AL
34—LODESTONE LODE
35—LONE CABIN PLACER
36—LOS ANGELES Nos. 2, 3 GYP.
37—MARRIS QUARTZ
38—McANANY & RICE ET AL
39—MILWAUKEE ET AL
40—MONITOR CONSOLIDATED
41—MONTE CRISTO
42—NEXT BEST PLACER
43—NIL DESPERANDUM PL.
44—NOVERTO PLACER
45—ORANGE BLOSSOM
46—ORION
47—OTTO MINE
48—PHELPS PLACER
49—PURITAN QUARTZ
50—RED CLOUD
51—RED ROVER
52—W. H. RUSSEL
53—SAN GABRIEL MINING CORP. MIN. ENTRY
54—SCORELLA PLACERS
55—SOUTH EXTENSION O.K. ET AL
56—TITAN LODE
57—J. J. WEST ET AL
58—WHITE FELSPAR PLACER
59—WOODMAN PLACER
60—WROCKLOFF MINE
61—THE DICALITE CO.

Accompanying report
by R. J. Sampson,
Division of Mines,
State of California,
Department of Natural Resources.

CHROMITE

Chromic iron ore occurs as float in the vicinity of Acton, Bouquet Canyon and Harold, a station on the Southern Pacific Railroad.

Acton Chromite Deposit is located in T. 5 N., R. 13 W., S. B. and M., not far from the railroad station at Acton. The occurrence is not of commercial importance.

Bibl: State Mineralogist's Reports XV, p. 471; XXIII, p. 288.

Bouquet Canyon Deposits. Considerable high-grade float has been found near the summit of the ridge north of Bouquet Canyon, 13 miles north of Saugus.

As yet no lens of ore has been found in place.

Bibl: State Mineralogist's Report XXIII, p. 288.

Evert Chromite Deposit is located one mile west of Harold, a station on the Southern Pacific Railroad.

Bibl: State Mineralogist's Reports XV, p. 471; XXIII, p. 288.

COBALT

Occurrence of cobalt has been noted in several localities in Los Angeles County but to date no commercial production has resulted. It occurs in Pacoima Canyon in deposits of complex ores, carrying antimony, copper, nickel, lead and zinc, also in the Kelsey mine (see under Lead-Silver-Zinc) in the Silver Mountain district.

COPPER

There are no producing copper mines in the county, but copper ores occur near Acton, at Black Mountain, east of Palmdale and on Santa Catalina Island. Copper also occurs as chalcopyrite in the complex ores of Pacoima Canyon. Exploration and development on the deposits near Acton were attempted in 1889 and the Black Mountain deposits were prospected in 1908 but no commercial production was made. The only active development in recent years is on the deposits located near Acton, which was started in 1926, by *Allen Mines Company,* of Los Angeles.

Black Mountain Deposits. These deposits are located 27 miles southeast of Lancaster on Black Mountain. The ore occurs as malachite and carries values in gold and silver. There is a series of parallel veins in gneiss that strike northwest. Widths vary from 12 inches to 2 ft. A number of shafts have been sunk on the different vein showings to depths of 10 ft. to 15 ft. The ore is reported to carry from 2% to 7% copper with from $3 to $7 in gold and silver. Eight claims are owned by J. L. Watts, of Lancaster, California.

A copper deposit formerly worked by the *Palm Development Company* in 1908 is located in Sec. 30, T. 5 N., R. 10 W., S. B. B. and M., 12 miles southeast of Palmdale. The ore occurred in a porphyritic dike, which averaged 180 ft. in width. The dike is mineralized with malachite and carries values in gold and silver.

Bibl: State Mineralogist's Report XV, p. 471.

Clearwater Copper Group comprising 5 claims and mill site, is situated in Sec. 21, T. 6 N., R. 15 W., in Clearwater Canyon, approxi-

mately 12 miles north of Saugus. Elevation 2500 ft. Owner, Arthur R. Plumb, Los Angeles.

Copper carbonates occur in fractures in hornblende schist which is enclosed in gneissoid granite. Strike NE.-SW.

Development consists of open-cuts and a cross-cut driven west 100 ft. Reported to have encountered small lenses of copper carbonates carrying from 0.5% to 2% copper. Idle.

Denver Mining and Milling Company. W. S. McGrew, W. B. Folger, National Bank Bldg., San Fernando, California, own a group of claims known as Denver, Chance, Fenner, Indicator and Red Ledge, 12 miles northeast of San Fernando, in Pacoima Canyon. Elevation 2610 ft.

There is a series of parallel quartz veins that occur in schist and gneiss and strike N. 80° E. and dip 60° to 80° south. The veins vary in width from 2 ft. to 4 ft., with the exception of the Red Ledge vein which in places is 20 ft. to 50 ft. wide. The ore is a complex sulphide, carrying massive pyrrhotite, chalcopyrite, galena and sphalerite and stated to carry traces of nickel, cobalt and antimony.

These sulphides occur in lenticular masses in the several quartz veins. Development consists of a number of shafts and tunnels on the different veins. Idle.

Bibl: State Mineralogist's Report XVII, p. 318.

King of West Mine. It is located one mile south of Acton, just north of the Southern Pacific Railroad tracks. Holdings comprise 80 acres of patented land. Owner, R. E. Nickel, Acton, California.

A vein of quartz 4 ft. in width occurs in granite. It strikes north and has a vertical dip. The quartz is mineralized with malachite, bornite and carries values in gold and silver.

Development consists of a shaft sunk on the vein to a vertical depth of 150 ft. and a number of other shallow shafts. Idle.

Parker Mountain Mine (Emma Group). This property, comprising 100 acres of patented land and 5 claims held by location, is 2 miles south of Acton. Owner, *Highland Mining Syndicate;* Wm. B. Conover, agent, Bradbury Building, Los Angeles.

For history, description and development of this property see:

Bibl: State Mineralogist's Reports XV, p. 472; XXIII, pp. 290-291.

Silver Mountain Group of 3 claims on San Gabriel River, is 8 miles from Azusa. Owner, E. Morgan, 3216 Tyburn Street, Los Angeles.

Here a vein 18 inches to 3 ft. in width is reported to carry 4% to 6% copper, $3 in gold and 20 oz. to 40 oz. in silver. Development consists of a 40-ft. cross-cut tunnel to vein. Idle.

Winter Creek Group, comprising 8 claims in Sec. 3, T. 1 N., R. 11 W., is on San Anita creek, about 5 miles north of Sierra Madre. Owner, O. L. Roberts, Roberts Camp, California.

Country rock consists of granite and diorite. There are two parallel veins approximately 100 ft. apart; strike NE, dip 70° NW. Veins vary from 12 inches to 3 ft. in width. Mineralization consists of chalcopyrite, bornite, pyrite, gold, silver and molybdenite. Surface samples

are reported to carry from 10% to 15% copper, $2 to $8 gold, one ounce to 80 oz. silver and 0.5% to one per cent molybdenite.

Development consists of a lower cross-cut tunnel, elevation 1800 ft., driven southwest 170 ft. on contact of granite and diorite. It cut the first vein at 80 ft., width 12 inches to 3 ft. A drift south 100 ft. encountered a lens of ore 80 ft. long. In the face of the tunnel the vein is 3 ft. wide. About 300 ft. northeast of these workings a tunnel has been driven southwest 40 ft. on a 12-inch quartz vein stained with copper, carrying pyrite and molybdenite. The granite footwall carries molybdenite across 4 or 5 ft.

On the western or No. 2 vein, 200 ft. north of the 40-ft. tunnel, a drift has been driven north 80 ft., showing a vein of quartz 12 inches to 3 feet wide mineralized with chalcopyrite, pyrite and molybdenite. Thirty feet above is another 50-ft. tunnel on the vein which here carries azurite and malachite in addition to the minerals listed above.

Equipment consists of 140-cu. ft. compressor driven by gasoline engine. Idle.

GOLD

Gold [1] was first discovered in Los Angeles County in 1834 and the placers of San Francisquito, Placerita, Casteca and San Feliciana canyons worked between the years of 1834 and 1838 by the priests of San Fernando and Santa Buena Ventura missions. The placers of San Gabriel Canyon were worked by the priests of San Gabriel Mission and also by the native Californians until the discovery of gold in northern California by Marshall in 1848 at Sutter's mill. Desultory placer mining by individuals has been carried on at irregular intervals since that date. This work has been somewhat intensified since 1930, particularly in San Francisquito and Boquet canyons. Several dragline and power shovel operations have been attempted without any notable success. This later activity was caused largely by its proximity to Los Angeles and the unemployment situation at that time.

In December, 1933, while attempting to develop water in Sec. 27, T. 8 N., R. 16 W., a gold-bearing vein was discovered by W. J. Rogers. This property is on the north slope of Sawmill mountain on the south side of Antelope Valley about 16 miles east of Gorman in what is known as the Neenach district. It was developed by Rogers and Gentry. Shipments of ore to the Tropico Mill near Rosamond created some excitement and considerable prospecting was done in the immediate vicinity.

The rocks of this district are crystallized limestone, quartzite and granite. The San Andreas Fault traverses the area some two to three miles to the south and there are many minor fractures which are roughly parallel to its course.

Production from tthe Rogers-Gentry Mine and the Brite lease (also on the Rogers property) had exceeded $100,000 in the early part of 1935 and the average value of the ores was about $40 per ton, to that time.

Another interesting development is that of the old New York Mine (now called the Governor) in the Mint Canyon area. This old property, worked many years ago, relocated and worked in 1889, later

[1] Rept. XXIII of the State Mineralogist, p. 291.

worked by Governor Gage, has been rehabilitated and successfully developed by Francis Gage, son of the governor.

The principal rocks of this area are granitic. The main mass of granodiorite has been intruded by numerous more basic dikes which cut the veins, usually with a displacement of only a very few feet. Two or three faults have also been encountered, the maximum displacement noted, to date (September, 1936) being some 47 ft.

The success of this operation has stimulated prospecting in this area, but, as yet, no other important developments have taken place.

For further general information on the gold mining districts of this county reference may be made to the following reports of the State Mineralogist: IX, pp. 190-210; XV, pp. 473-477; XXIII, pp. 291-292.

Mines

Allison Mine (quartz). It is located on the west slope of Sheep Mountain, 5 miles northeast of Azusa. Owner, Allison Mines Company, Azusa, California.

Allen and Bailey Lease was on the SW¼, SW¼, Sec. 14, T. 5 N., R. 16 W., in San Francisquito Canyon, 8 miles north of Saugus. It comprised 20 acres and was leased by J. O. Frazer to R. A. Allen, of Glendale, California.

Here, in 1932, an attempt was made to hydraulic bench gravel on the west side of the canyon. A 2-stage centrifugal pump supplied 500 g.p.m. from the creek bed. After washing about 2500 cu. yd. the project was abandoned.

Big Horn Mine, comprising 15 claims and 2 mill sites, all patented, is in Sec. 7 and 8, T. 3 N., R. 8 W., on North Baldy Mountain, 28 miles east of Palmdale and 9 miles from Valyermo post office. Elevation approximately 7600 ft. Owner, Mrs. F. C. Fenner, 1017 West Lake, Los Angeles. Leased to R. C. Huffman, Buffalo, New York.[1]

The vein, which strikes N. 40° to 60° E. and dips 17° NW., lies between granitic gneiss and mica schist. By isolated outcrops it has been traced for 300 ft. along its outcrop. Its average width is approximately 25 ft. Development consists of a series of tunnels as follows:

Tunnel No. 4	Elevation 7600 ft.	Length 394 ft.
Tunnel No. 3	Elevation 7200 ft.	Length 210 ft.
Tunnel No. 9	Elevation 6896 ft.	Length 713 ft.
Tunnel No. 6	Elevation 6800 ft.	Length 862 ft.
Tunnel No. 1 (Fenner)	Elevation 6615 ft.	Length 1200 ft.
Tunnel No. 10	Elevation 6300 ft.	Length 802 ft.

This work has developed two ore-shoots, one 240 ft. long by 60 ft. wide, by 360 ft. on the dip; the other 240 ft. long, 13 ft. thick and 580 ft. from the outcrop. It is estimated that there is exposed 422,000 tons of ore. The two shoots are separated by 160 ft. of barren ground. The limits of the ore-bearing zone are marked by two faults, 640 ft. apart. These faults are roughly parallel, strike E.-W., dip 40° S.

Ore mined and treated in 10-stamp mill between July, 1904 and October, 1906 was 15,564 tons from which there was recoverd $39,-720.18, or $2.55 a ton, with a tailings loss of $0.35 to $0.70.

[1] Since this report was written the property has been optioned to the American Metal Co., Ltd., of New York, Vincent M. Burnhart, supt.

Mine equipment consists of 2-stage Denver-Gardner compressor driven by electric power.

Mill equipment: 50-ton coarse-ore bin to jaw crusher, elevator to 75-ton crushed ore bin, belt feeder to 4 ft. by 8 ft. rod mill in closed circuit with Dorr duplex classifier to conditioner and 2 Kraut flotation cells, followed by Wilfley pilot table and Dorrco filter; capacity 75 tons.

Power is bought from Southern California Edison Co. Idle (Oct., 1936).

Black Hawk Group, consisting of 4 claims in Cow Springs canyon, is 4½ miles east of Sandbergs, on the old Ridge Route. Owners, John De Shazo and Edna De Shazo, 449 North Gardner, Los Angeles.

A series of narrow veins occurs in the granitic country rock which appears to be badly faulted.

Development consists of a 50-ft. tunnel and 20-ft. winze on a narrow vein which strikes E.-W. and dips 30°-40° S. No commercial ore has been encountered. Idle.

Bradshaw Lease lies between the Governor and Red Rover mines in Mint canyon, about 18 miles east of Saugus. Leased to R. C. Bradshaw, of Acton, California, and associates.

Here a cross-cut tunnel has been driven SE 300 ft. through diorite, which for the last 100 ft. has been highly altered, due to shearing. It is proposed to drive this tunnel 500 ft. to get under a quartz outcrop on the hill above. This vein has a north-south strike and dips west.

The property is equipped with a portable compressor. Three men are driving tunnel.

Brite Lease, from Roger and Gentry in the Neenach district, was on the line between Sec. 26 and 27, T. 8 N., R. 16 W., S. B. B. M.

This lease was on a small piece of ground to 100 ft. in depth. The vein, which occurs in the granitic rock of this area, is supposed to be a continuation of the Rogers and Gentry vein.

Brite sunk to 100 ft. and mined an ore-shoot 185 ft. long from 2 ft. to 5 ft. wide. His shipments to the Tropico mill averaged above $40 per ton. Total production was in excess of $50,000. (See also Russell and Myler Lease).

Champion Group, comprising 15 claims, is in Sec. 28, T. 5 N., R. 14 W., S. B. B. M., 3½ miles northeast of Saugus. Owner, S. B. Dunn, Los Angeles.

Here 4 parallel quartz veins occur in the granite. Having a general east-west strike, they vary in width from 2 ft. to 4 ft. Near the surface the ore is oxidized but at 50 ft. in depth it is heavily mineralized with pyrite. It is said to average 0.55 oz. of gold per ton.

Development consists of two tunnels and a number of shallow prospect shafts. Total development on the various veins amounts to 2000 ft. Idle.

Bibl: State Mineralogist's Report XXIII, p. 292.

Cruzan Placer Mine, consisting of 640 acres, is in Texas Canyon, 12.8 miles northeast of Saugus. Owner, W. H. Cruzan, Newhall, California.

Neenach District—Brite Lease in foreground

Photo by Ralph Baverstock

The auriferous gravels are on the north side of the canyon, varying in depth from 8 ft. to 10 ft.

The deposit is worked spasmodically, principally in the winter months, due to scarcity of water which is supplied by a dam in Texas canyon, one mile above the workings.

Bibl: State Mineralogist's Report XXIII, p. 292.

Dawn Mine, comprising 160 acres, is in the SW. ¼ of Sec. 25, T. 2 N., R. 12 W., S. B. B. M., 6 miles north of Altadena. It is in Millard Canyon on the southwest slope of Mt. Lowe. Elevation 3000. Owner, Mrs. L. T. Ryan, Los Angeles. Under lease to L. W. Hunter, 715 W. 32d St., Los Angeles.

The country rock is granitic. The vein strikes N. 70° W., with a vertical dip. It has been faulted along a north-south line, with a displacement of about 150 ft. It is a quartz-filled fissure from 3 ft. to 5 ft. wide and is mineralized with iron sulphides, a little chalcopyrite and some free gold.

Development consists of a tunnel driven north along a fault line 50 ft. to the vein; drift NW. 100 ft. on vein. At intersection of cross-cut and vein, a winze has been sunk reported to be 55 ft. deep on the vein 3 ft. to 4 ft. wide. Values in this winze are said to be $20 to $30 per ton. Also at this point a raise, on the vein has been put up 40 ft. This raise is to connect with winze from upper tunnel and the total distance through is about 50 ft. There is also some 600 ft. of drifting in the unaltered granitic country rock.

Upper tunnel is 60 ft. above the lower. It is a cross-cut N. 10 ft. to vein, drift 150 ft. NW. At the cross-cut, a winze has been started to connect with raise from below. It is about 4 ft. deep. Here the vein is 5 ft. wide and is reported to carry good values.

About one-half mile down the creek from the mine there has been a small mill erected consisting of the following:

Grizzly with 1-in. openings; elevator to small bin, to two vibrating screens, 20 and 30 mesh; oversize to combined crusher and rolls, followed by one sand and one slime table. Four men working.

Bibl: State Mineralogist's Reports XV, p. 477; XXIII, pp. 292-293.

Dewey Group consists of 4 claims and a mill site on the southeast slope of Mount Gleason near the head-waters of Mill Creek, 8 miles south of Acton. Owner, I. Dewey, Glendale, California.

Bibl: State Mineralogist's Report XXIII, p. 293.

Don Mine is on the south side of Mint Canyon about 18 miles east of Saugus. It is leased to F. H. Hamilton by the owner, O. L. Corbin, 121 Carlton St., Pasadena, California.

The vein, which occurs in granodiorite, has a N.-S. strike and dips 70° W. It varies from a few inches to 2½ ft. in width.

It is developed by a shaft 80 ft. on a 70° incline. On the 30-ft. level a drift has been driven southeast 60 ft. and 40 ft. southeast on the 80-ft. level. Three hundred feet southeast of this shaft a cross-cut tunnel was driven southwest 265 ft. At 150 ft. there is a drift northwest 90 ft.

Governor Mine
Crusher and ore bin

Governor mill and power plant
under construction

A shipment of 9 tons is said to have returned $40 per ton.
One man working on 80-ft. level.

Double Eagle Mine, comprising 6 claims, is 19 miles northeast of Saugus, in Sec. 21, T. 6 N., R. 14 W., S. B. B. and M., on the Bouquet Canyon-Elizabeth Lake road. Owners, J. C. Nimmo and F. W. Kent, Saugus, California.

A series of parallel veins occurs in quartz monzonite. These veins have been developed by several shallow shafts and short tunnels. The ores near the surface are said to carry from $8 to $10 per ton. Idle.

Bibl: State Mineralogist's Reports XXIII, p. 293; XXX, p. 407.

Dry Canyon Lease. Some 40 acres in Dry Canyon, on the Conroy Ranch, about 3½ miles east of Saugus, was leased to *Marsons Gold Co.*, M. Wilson, president, La Canada, California, by the *Soledad Placer Co.*

The work on this property was done in the bottom of a canyon, tributary to Dry canyon from the east. Depth of gravel from 15 ft. to 30 ft.

A power shovel with one-cubic-yard dipper fed direct to a hopper, thence to 4 ft. by 20 ft. trommel, 3 3/16 in. screen to drag classifier to four 36-in. Ainley bowls to dewatering belt and tailings stacker. Five men were employed on a shift. Reported to have recovered 6 ounces per three-shift day.

Eagle Mine (See Mount Gleason).

El Centro Mine consisting of 6 claims is located 12 miles west of Cajon, on the Prairie Fork of San Gabriel River. Elevation 5550 ft. Owner, Guy Pullen, San Bernardino, California.

The ore occurs in a basic porphyry dike, heavily stained with hematite. Development consists of a tunnel 50 ft. in length and shallow shafts. Idle.

Gold Dyke Mining Co. (Tuttle Lease). This property, consisting of 20 acres, is leased by the *Rivera Mining Co.* to the *Big Dyke Mining Co.*, which is composed of W. W. Tuttle, 803 Kodak Drive, Fred Fisher, 627 Occidental, and others of Los Angeles. It is in the Neenach district, about 1½ miles east of Rogers and Gentry Mine.

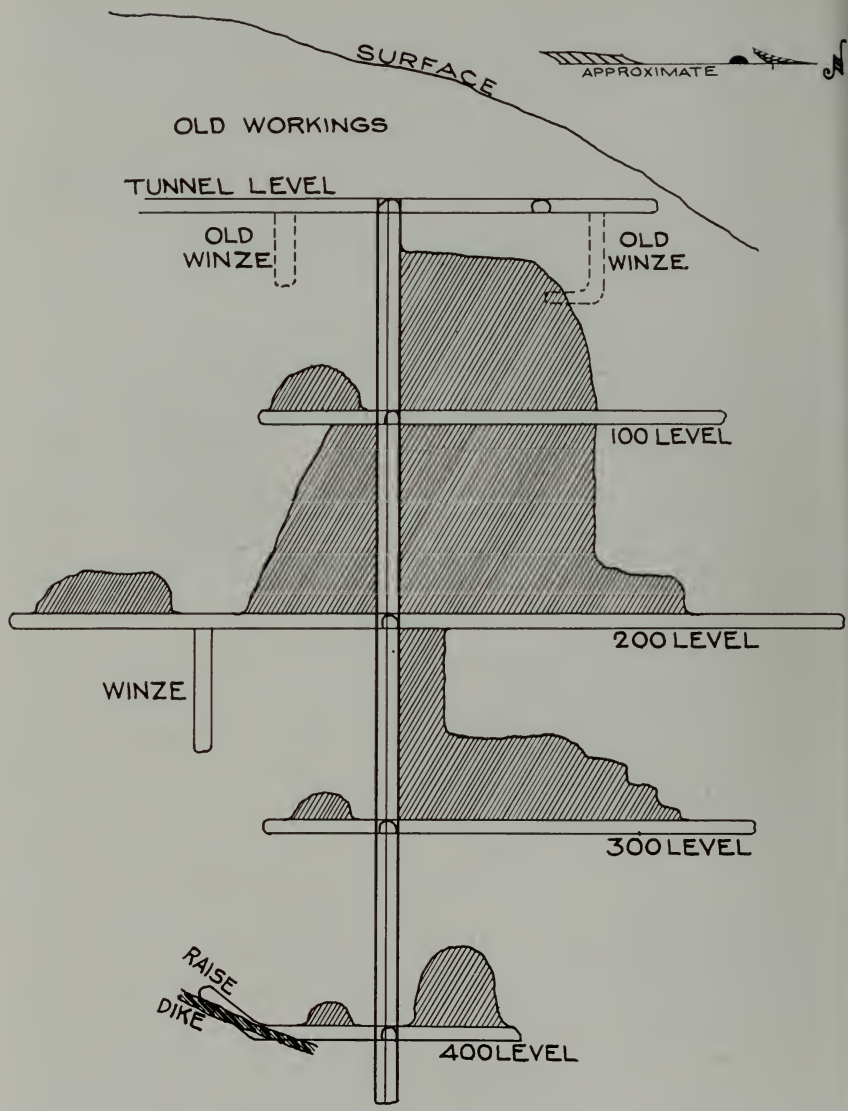
The gold here occurs free, in a pegmatite dike in the granitic country rock. The dike has a N. 30° W. strike and dips 55° SW. It is from 12 ft. to 30 ft. thick. Average value is said to be $15 per ton, all free. Coarse gold may be panned from fines on the dump.

Development consists of a 70-ft. shaft. At 15, 30 and 40-ft. levels, cross-cuts northeast have been made into the dike, some 10 ft. from the shaft.

The mill consists of bin to belt feeder to Utility hammer mill and an air-operated 800-lb. stamp, followed by amalgamation plates, all operated by an automobile engine.

Three men employed erecting mill.

Governor Mine (New York), consisting of 4 claims, is 3 miles north of Acton and 20 miles east of Saugus. It is in the Cedar Mining dis-



LONGITUDINAL SECTION

GOVERNOR MINE

0 50 100 FT.

trict. Elevation 3000 ft. Owners, Chas. H. McWilliams, Chas. L. Hillard and J. F. Gage, 725 S. Figueroa St., Los Angeles.

This property has been one of the largest producers in the county, having been worked intermittently since about 1880.

The vein is a quartz-filled fissure in quartz diorite. The strike is N. 20° W. and it dips 75° NE. Average width is about 4 ft. Mineralization consists of iron sulphides and free gold.

There are a number of dikes which cut the vein with from 2 ft. to 5 ft. displacement. A fault was encountered just below the tunnel level which displaced the vein some 25 ft. to the east (going down). The ore-shoot consists of a series of overlapping lenses of quartz in the vein. It has been mined for a length of 150 ft. on the 100 level, 215 ft. on the 200, and 140 ft. on the 300 level. Its apparent length on the 200 and 300-ft. levels, as now exposed, is approximately 300 ft.

Governor Mill

Recent developments on the 400-ft. level indicate a possible extension of this shoot to the south in territory unexplored heretofore.

Development consists of main working tunnel 800 ft. in length from which a vertical shaft has been sunk to a depth of 430 ft. with levels at 100, 200, 300 and 400-ft. horizons. Drifts have been driven on the various levels as follows:

Level	*Feet*	*Feet*
100	N. 160	S. 65
200	N. 225	S. 190
300	N. 180	S. 62
400	N. 64	S. 62

A raise has been put up 30 ft. at the face of the 400 south drift.

At 30 ft. south of the shaft on the 200, a winze has been sunk 62 ft. In the old workings a winze was sunk both north and south of the present shaft site, with some drifting about 60 ft. below the tunnel level.

A filled stope method of mining is used and the average width of stopes is about 6 ft.

Mine equipment consists of 6-cylinder, marine engine, driving 220 V., 104 amp. generator and 6 by 4, 4 by 5 air compressor. Blacksmith shop complete with drill sharpener, etc. At the mine bin is a 6-inch by 8-inch jaw crusher driven by 15-h.p. motor.

The mill which is just south of Acton, is approximately 5 miles from the mine. It consists of 5 ft. by 3 ft. ball mill, amalgamation trap, Simplex Dorr classifier to 3 rougher and one cleaner flotation cell. Power is supplied by 2-cylinder, 120-h.p. Type Y, Fairbanks-Morse diesel engine, with generator. Machines in mill have individual motor drives. It is claimed that 95% extraction is made. Capacity about 30 tons per day.

Fourteen men are employed at the mine and 6 at the mill.

Bibl: (New York Mine) State Mineralogist's Reports IX, p. 192; XV, p. 476; XXIII, pp. 294-295.

Helene Mine (see p. 195).

Lovell Group comprising 5 claims and a mill site is on a ridge north of Little Tujunga canyon in Sec. 28, T. 3 N., R. 14 W. Elevation 2000 feet. Owners, Frederick A. Lovell and Mrs. Jean M. Philbin, of Los Angeles.

On these claims tunnels have been driven from 40 to 300 ft. in length. There is also an outcrop of dolomite; strike north-south; width from 100 to 150 ft.

Only annual assessment work is being done.

Lovell North Group, consisting of 5 claims and a mill site, is located on a ridge northwest of Little Tujunga canyon about three-quarters of a mile north of the Lovell Group. Owners, Frederick A. Lovell and Mrs. Jean M. Philbin, of Los Angeles.

A tunnel is being driven northwest in hornblende granite under a flat fault, above which the granite is gneissoid.

Four men are driving the tunnel.

Lummis Group, comprising 4 claims, is located 7 miles southeast of Acton, on the north fork of Alder creek, in Sec. 8, T. 3 N., R. 11 W., S. B. B. M. Elevation 4700 ft. Owner, Capt. Lummis, on the property.

A series of shallow shafts and short tunnels have exposed a vein in the granitic country rock of this area. The vein which is 2 feet in width, has an easterly strike. Idle, except for annual assessment work.

Mint Canyon. On the south side of this canyon about one-half mile south of the highway and some 15 miles east of Saugus there is a large quartz outcrop on which has been sunk a shaft 40 ft. deep. Its strike is N. 60° W., dip 65° NE. It outcrops on the top of a knoll for a length of about 50 feet. On the hanging-wall side there is about 4 feet of vitreous, iron-stained quartz which looks as if it might carry values. No further information could be obtained.

Monte Christo Mine, comprising 23 claims, is situated on the headwaters of Mill creek, 18 miles southeast of Acton. Elevation about 4600 ft. Owner, F. W. Carlisle, Box 7, Palmdale, California.

This property has been divided into two parts and leased to separate parties. The eastern part consisting of 17 claims has been leased to W. W. Hartman, 109 Street and Central Avenue, Los Angeles.

Four parallel veins occur in the granite. Strike N. 20° W., dip 80° E. These veins vary in width from 2 to 6 ft. The only develop-

ment is on the Monte Christo vein and consists of two tunnels and a winze 130 ft. deep. At an elevation of 4650 ft., a tunnel has been driven north 425 ft. At 87 ft. from the portal, a winze has been sunk 130 ft. At the 50 ft. level there is a drift N. 60 ft., with raise to tunnel level. On the 130 level there is a drift N. 50 ft. This work has exposed 4 shoots of ore, each about 35 ft. long by 2½ to 3 ft. wide. These shoots have been stoped from tunnel level to surface with a reported production of $70,000.

Lower tunnel, 120 ft. below has been driven N. 425 ft., with 25 ft. cross-cut west of face. The ores above the upper tunnel were oxidized but in the lower tunnel it is pyritic and is reported to carry from $14 to $18 per ton.

Property is equipped with portable compressor. Five men are employed.

West Vein Lease, consisting of 6 claims, is 1200 feet west of the Monte Christo. It is leased to Walter W. Gilkey and Crouse L. Elgin, on the property.

This quartz vein occurs in the granite. Its strike is N. 5° W., dip 80° E. It varies in width from a few inches up to 7 feet. The hanging wall is well defined but the foot is not. It has been exposed for a length of about 3000 feet on the hillside by a series of open-cuts and short tunnels. Even at the surface sulphides occur in splotches in the quartz. Mineralization consists of pyrite, marcasite, chalcopyrite and occasionally sphalerite.

At an elevation of 4550 feet a tunnel has been driven on the vein, north 130 feet. At 40 feet from the portal a winze has been put down 30 feet. There is also a small underhand stope about 16 feet long by 2½ feet wide. This ore is said to have run from $18 to $40 per ton.

At an elevation of 4500 feet a cross-cut tunnel N. 30° W. was driven 90 feet to the vein, drift N. 50 ft. on the vein. Where cross-cut strikes vein it is faulted. Fault strikes N. 70° W. Last 15 feet of drift shows vein 4 to 6 ft. between walls, with 3 ft. of quartz, carrying sulphides.

Four men working in the lower tunnel.

Bibl: State Mineralogist's Reports XIII, p. 204; XXIII, p. 294.

Mount Gleason Mine (Eagle) is on the north slope of Mt. Gleason, 6 miles south of Acton. Holdings comprise two patented claims, 17 claims held by location and a mill site. Elevation 6000 ft. Owner, B. F. Grant, 625 W. 41 Drive, Los Angeles.

Eagle vein strikes NW.-SE.; dip 80° NE. in the granitic country rock. In the ore-shoot the vein is from 2½ to 5 ft. wide, averaging about 4 ft. The quartz is shattered. The metallic minerals near the surface are partially oxidized, with streaks of heavy sulphides showing in the vein.

The property has been developed by four tunnels from 200 to 700 ft. long, as shown in the accompanying sketch. The ore-shoot apparently rakes to the north and has been opened for a length of about 200 ft. Average value of samples taken by former operators was $6.80 per ton.

There are a dwelling and some small shop buildings on the property, together with the ruins of a small milling plant.

Idle.

Bibl: State Mineralogist's Reports IX, p. 195; XI, p. 247; XII, p. 152; XIII, p. 204; XXIII, p. 293.

Native Son Mine, consisting of 7 claims, is located on the south slope of the ridge north of the Prairie fork of San Gabriel River, 12 miles west of Cajon, a station on the Santa Fe Railroad. Elevation 5800 ft. Owner, Native Son Mining Co.-Chas. Ward, San Bernardino.

The gold occurs in quartz stringers in mica schist and gneiss. The veins strike northeast and dip 50° northwest. The ore is free-milling with a small percentage of iron sulphides.

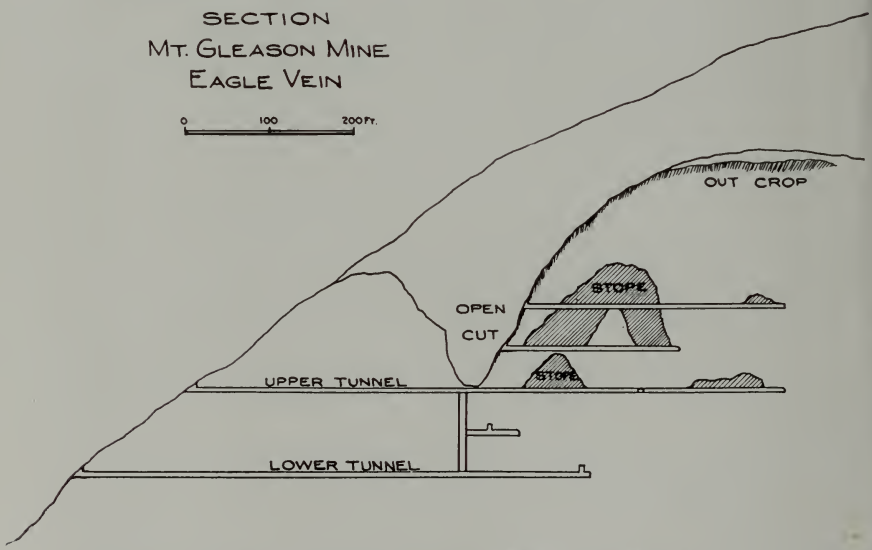
It has been developed by 6 tunnels, varying from 100 to 750 ft. in length.

Idle except for assessment work.

Bibl: State Mineralogist's Report XXIII, p. 294.

New York Mine (See Governor).

Bibl: State Mineralogist's Reports IX, p. 192; XV, p. 476; XXIII, pp. 294-295.



Ore Hill Group (formerly *Denver Mining & Milling Co.*) consisting of 4 claims, is 12 miles northeast of San Fernando in Pacoima Canyon. Elevation 2600 ft. Owner, L. I. Gordon, 504 N. Workman St., San Fernando.

A series of quartz veins here occurs in schist and gneiss. The general strike is about E.-W., dipping from 55° to 75° S. They vary in width from 2 ft. to 4 ft., with the exception of the Red Ledge which in places is 20 ft. to 50 ft. wide.

Mineralization consists of massive pyrrhotite, chalcopyrite, galena and sphalerite. It is reported that assays up to 200 ounces in silver per ton have been obtained.

Development consists of a number of short tunnels and shallow shafts, none of which were accessible at the time of visit. Idle.

Bibl: State Mineralogist's Reports XVII, p. 318; XXIII, pp. 289-290.

Padre Mine, comprising 5 claims, is on the north slope of Mt. Gleason about 6 miles south of Acton and one-half mile northwest of the Mount Gleason Mine. Elevation 6500 ft. Owner E. H. Barmore, 5223½ De Longpre Ave., Hollywood.

The vein in the granitic country rock strikes NW.-SE., dips about 80° NE. and varies in width from 18 in. to 3½ ft. The ore occurs as quartz lenses in the vein. Two such shoots each about 40 ft. long have been encountered.

Development consists of a tunnel driven northwest 200 ft. on the vein and a cross-cut north 35 ft. in the country rock. At 15 ft. from the portal a shaft intersects the tunnel and continues to a depth of 35 ft. below. It was filled with water but is said to expose the vein which here is 3 ft. wide. No idea of average values could be obtained.

A small dry concentrating plant which had been erected is now abandoned and the operator intends to install a small ball mill.

One man working on mill site.

Puritan Mine (Union), consisting of one patented claim, is in Sec. 21, T. 5 N., R. 13 W. on the south side of Mint Canyon about 18 miles east of Saugus and 4 miles northwest of Acton. Elevation 3350 ft. Owners, T. G. Schaeffer and Ira L. Hauser, Acton, California.

A quartz vein 4 ft. in width occurs in the schist. Its strike is northwest and dips 80° SW. Former development consisted of a shaft 140 ft. deep, with a drift southeast from 60 ft. level a distance of 60 ft. which was stoped to the surface.

Was leased to R. P. Fenner about 1934. Fifty feet north of the hold shaft, Fenner sunk 65 ft. on a 60° incline. It is said that he cross-cut from the bottom of this shaft about 20 ft. in three directions, north, east and west. He is reported to have encountered an 18 in. vein carrying high values.

It would require a cross-cut of about 40 ft. north to intersect the Puritan vein. There is a 5-stamp mill on the property. Idle.

Bibl: State Mineralogist's Report XXIII, p. 295.

Puritan Extension comprising 4 claims entirely surrounds the Puritan claim. Owner, Lewis S. Winterburn, 25 South Mentor Ave., Los Angeles.

On these claims a shaft has been sunk 70 ft. with a cross-cut 20 ft. north. By extending the cross-cut about 15 ft. it would intersect a vein which shows on the surface. This vein is in sheared granodiorite, has an east-west strike and appears to be about 3 ft. wide. Idle except for assessment work.

Ragan and Williams Lease of approximately 10 acres is just south of the Brite lease on ground owned by Rogers and Gentry. It is on the south slope of the hills in which most of the mining has been done in the Neenach district.

A tunnel has been driven west 250 ft. toward the Brite ground. The Brite vein should cross the line at about 105 ft. below this tunnel. The tunnel would have to be driven approximately 300 ft. further and a winze put down to encounter the vein. Idle.

Red Rover Mine, embracing 4 claims, is situated in the Cedar mining district, 4 miles north of Acton, in Sec. 22 and 23, T. 5 N., R. 13

W., S. B. B. M. Elevation 3350 ft. Owner, Chas. H. McWilliams and J. F. Gage, 725 S. Figueroa St., Los Angeles.

This has been the most productive mine of the district but has now been idle for years. Interest in its future possibilities has been stimulated by the recent success of its neighbor, the Governor Mine which is about one-half mile east.

The vein occurs in the quartz diorite country rock of the district. Its strike is N. 63° W., dip 80° SW. Its average width is said to be 3 ft.

It was developed and worked through an incline shaft on the vein, 535 ft. deep and a vertical shaft 400 ft. deep. There are three other

Tunnel level, Rogers and Gentry Mine
Neenach District

shafts on the property from 100 to 150 ft. deep. The ore milled from these workings is said to have averaged $10 per ton in gold. Idle.

Bibl: State Mineralogist's Reports VIII, p. 333; IX, p. 191; XI, p. 246; XII, p. 153; XIII, p. 204; XV, p. 476; XXIII, p. 295; XXX, p. 407.

Rivera Mining Company's property, consisting of 80 acres in Sec. 26, T. 8 N., R. 16 W., S. B. B. M., in the Neenach district, was divided into 12 leases. C. A. Andrews, Bakersfield, is president; Bert Rivera, assistant manager, on the property.

Considerable prospecting was done on this ground by various lessees. The work consisted of short tunnels and shallow shafts. No serious attempts to produce resulted except as described under Gold Dyke Mine. All of these leases are now idle.

Robinette Lease (placer) is situated at the junction of Haskell and Bouquet canyons. The ground was leased from Smith Bros. by Earl Robinette and associates, all of Torrance, California.

Robinette and his associates sunk 140 ft. on a 20° incline in the level floor of the canyon. Throughout the entire distance the shaft was in clay and unsorted, angular to round gravel and boulders. It was claimed that the entire mass carried some values with occasional concentrations, presumably under large boulders.

Water was obtained from a shaft which had formerly been sunk in the floor of the canyon to a depth of 160 ft. Idle.

Rogers and Gentry Mine, containing 160 acres, being the E. ½ of E. ½, Sec. 27, T. 8 S., R. 16 W., is on the south side of Antelope Valley, 6 miles south of Neenach and 28 miles west of Lancaster. This property is patented. Owners, W. J. Rogers and R. J. (?) Gentry, Neenach, California.

The vein occurs at the contact of granite with quartzite and limestone. Its strike is from N. 25° W. to N. 50° W., dip 45° SW. Its width varies from 2 ft. to 6 ft. The quartzite and limestone, alternately, form the hanging wall, with the granite on the foot. The ore is free-milling with a small percentage of pyrite.

This area is traversed by the San Andreas fault (some 3 miles south of the mine) and the ground is somewhat blocky and crushed but no considerable displacement of the vein has been encountered to date.

The mine was opened by a glory hole under which a tunnel was driven 150 ft. in length. From the tunnel level, a shaft has been sunk to 200 ft., with levels at 100 and 200 ft. There is a small stope on the 100 level southeast from the shaft. It is about 40 ft. long by 6 ft. wide by 20 ft. high. At the time of visit they were cross-cutting southwest for the vein on the 200 ft. level.

The ore was shipped to Burton Bros. Tropico mill and averaged from $40 to $50 per ton. Production from this property and the Brite lease has been well over $100,000.

Equipment consists of compressor, drills and hoist. Six men working, driving cross-cut.

Russell and Myler Lease (see Ventura-Neenach Mining Co.)

Scorella Placer, consisting of 40 acres, patented, is the NE¼ of SE¼, Sec. 1, T. 4 S., R. 16 E., S. B. B. M., 4½ miles northeast of Saugus. Owner, G. V. Scorella, Los Angeles. Was under lease to G. S. Hancock, 3339 West 8 St., Los Angeles.

Concentration of values by erosion of terrace gravels above occur in two gulches which run south into Bouquet canyon. The gravel is from 4 to 6 ft. thick and is reported to average 80 cents per yard.

Material was screened to ⅛ in. and run through 36 in. Ainlay bowl. Water was obtained from a neighboring ranch.

There are several short tunnels in each side of these gulches, one of them 90 ft. long. Patches of thoroughly assorted gravels were encountered in this tunnel. Idle.

Smith Bros. Placer, consisting of 40 acres, is in Haskell canyon, at its junction with Bouquet canyon, about 6 miles east of Saugus. Owners, J. A. and D. N. Smith, on the property.

A vertical shaft 50 ft. deep was sunk in the floor of the canyon and a drift driven east 140 ft. All of this work was in a sandy clay through which there is distributed boulders and some fine gravel, all unassorted. At the 140 level the drift was driven on a clay bed. The boulders are schist and granite. The material worked is some 10 ft. thick, immediately on top of the clay. The owners state that it runs 75 cents per yard.

Later a lease was granted to King C. Gillette, of Los Angeles, who built one mile of railroad and installed a washing plant. Gravel was hauled by two 8-ton gasoline motors from the benches on the north side of the canyon in 18-cu. yd. dump cars.

Material was run through 4 spiral concentrators 4 ft. in diameter. This operation was a failure and the property is now idle.

Soledad Placer Company's property, consisting of 1332 acres, is known as the *Conroy Ranch*. It is in Bouquet and Dry canyons, about 3 miles east of Saugus. It was purchased from the Conroy Estate. The Soledad Placer Co., W. J. Clark, of the Los Angeles Police Department, president, is composed largely of members of the Los Angeles Police Department.

The surface of the ridge between Bouquet and Dry canyons is covered with gravel, due to erosion of benches of this material on the hillside. These benches have been worked intermittently for years, by short tunnels and trenches. Dry washers were used to recover the gold.

The Soledad Placer Co. started operations in the spring of 1935. They installed a power, drag machine having a 2-cu. yd. bucket swung from a 90 ft. boom. Material was dropped onto a 4 in. grizzly to a 25 yd. hopper, to 3 by 27 ft. trommel, $\frac{1}{4}$ and $\frac{1}{8}$ in. screens, thence to three 36 in. Ainlay bowls, all mounted on steel frame on wheels, which was moved along with the drag. Capacity 40 yards per hour.

Water was obtained from the Los Angeles aqueduct which crosses the property.

Approximately 250,000 cubic yards of material was treated, largely from the base of the hill on the north side of Bouquet canyon. It was at first thought that they were recovering about 35 cents per yard at a cost of 7 cents. Idle.

Texas Canyon Placer Mine (Goldy B. Group), comprising 160 acres, is 10 miles northeast of Saugus in T. 4 N., R. 14 W. Owners, John Caspar and Robert Heinze, of Los Angeles.

The auriferous gravels occur in benches, on the north side above the canyon. The channel has a general northeast course and has been worked for a quarter of a mile in length. The gravel is from 6 ft. to 8 ft. thick, composed of metamorphic rocks, schist, slate, quartzite and some quartz. The gold is quite fine.

It is worked intermittently due to the scarcity of water.

Bibl: State Mineralogist's Report XXIII, p. 295.

Tuch and Dether (placer), consisting of 40 acres, SW$\frac{1}{4}$ of SW$\frac{1}{4}$, Sec. 14, T. 5 N., R. 16 W., S. B. B. and M., is in San Francisquito Canyon, about 12 miles northeast of Saugus. Owner, J. O. Frazer, on the property. Leased to Robert Allen, subleased to Tuch and Dether, of Los Angeles.

Here an attempt was made to hydraulic bench gravels resting on marine sediments on the south side of the canyon. The gravel is about 5 ft. thick and rests on a conglomerate bed rock.

A well was sunk 8 ft. in the bed of the canyon and a 500 g.p.m. pump installed. The sluice boxes were carried across the highway on trestle work.

After removal of about 500 cu. yards, work was discontinued.

Tuttle Lease (see Gold Dyke Mining Co.)

Ventura-Neenach Mining Co. (Russell & Myler Lease) includes the Brite Lease (*q. v.*) on a part of the Rogers-Gentry Mine in the Neenach district. The Brite Lease was to a depth of 100 ft. only. This lease takes all to 200 ft. below surface. It is on the line between Sec. 26 and 27, T. 8 N., R. 16 W., S. B. B. and M. The company is composed of C. E. Appling and Dr. Mosher, Ventura, California, and Sol E. Camp, on the ground.

About 50 ft. north of the Brite shaft, a shaft was sunk 200 ft. on 45° incline south. The vein strikes NW-SE and dips 45° SW, between quartz-monzonite walls, although quartzite outcrops about 100 ft. to the south. Levels have been driven at 100 ft. and 200 ft. On the 100 level a cross-cut was driven south 105 ft. to the Brite vein. At 90 ft, it encountered another vein, called the Wild vein. Drift southeast on this vein 40 ft. Vein 15 inches to 24 inches is reported to carry up to $25 to $30 per ton. Drift northwest 60 ft. on this vein to intersection with Brite vein. At intersection, 3½ to 4 ft. wide, said to average $40 per ton. The Brite vein was stoped above this level for a length of 125 ft., average width about 3 ft. Drift SE. 50 ft. cross-cut S. 60 ft. to another vein; drift NW. 15 ft., SE 40 ft. At end of cross-cut raised to connect with Brite's workings.

On 200 level, cross-cut 72 ft. to vein which here is 12 ft. wide but broken up. At time of visit this cross-cut was being carried further south.

Production from this lease has probably exceeded $50,000. Six men working.

Union Mine (see Puritan).

Bibl: State Mineralogist's Report XXIII, p. 295.

Western Graphite Co., C. W. Jones, president, 337 West Avenue 26, Los Angeles, has discontinued its operations on the graphite deposit 2 miles southwest of Hughes lake and has converted its flotation plant into a custom mill for gold ores.

The plant consists of 50-ton coarse ore bin, 3-inch grizzly, No. 2½ Wheeling Crusher, elevator to 18-ton crushed ore bin (drum sampler at head of elevator), belt feeder to 3 ft. by 6 ft. rod mill, corduroy tables to conditioner, to 4 flotation cells (Fagergren). Middlings are returned to classifier, tails to Wilfley table, concentrates to 3-ft. by 2-ft. Oliver filter. Capacity about 25 tons per day.

Ores are received from Neenach, Lone Pine and Barstow districts. A minimum charge of $4.50 per ton is made and the ore is bought on 90% of the assay value, with the gold figured at $33 per ounce.

They are now erecting a smelter with which to treat their flotation concentrates. It consists of a Scotch hearth, 5 ft. long, which is to act as roaster and sintering machine. The sinter is fed to a 3-ft.

MINING CLAIMS IN LOS ANGELES COUNTY

Name of mine	Location			Last owner's or operator's name and address*	Area, acres	Bibliography—State Mineralogists' Reports
	Sec.	Twp.	Range			
Atlanta et al. (Big Horn)	7, 8	3N.	8W.	F. C. Fenner et al., 1017 S. Wilshire, Los Angeles, California	271.68	XV, p. 477; XVII, p. 203; XXIII, p. 292
Alexander et al.	18 21, 28	3N.	14W.	Frederick A. Lovell, 1230 W. Adams, Los Angeles, California	107.699	
Bear Canyon Pl. Mine	16	4N.	14W.	C. F. Guthridge, 325 Central Bldg., Los Angeles	115.74	
Black Jack et al.				Santa Catalina Island Co., W. Wrigley, Jr.		XXIII, pp. 314-315
Bowers Mine	1	4N.	16W.	Imperial Rock Corp., 3232 E. 50th St., Los Angeles, Calif., Clarence Bowers, 435 W. Ocean Blvd., Long Beach, California		
Cruzan Placers	34	5N.	15W.	Rosie E. Cruzan, 919 E. 105th St., Los Angeles	80.00	XXIII, p. 292
Cruzan Placers	3	4N.	15W.	Rosie E. Cruzan, 919 E. 105th St., Los Angeles	237.01	
Cruzan Placers	3	4N.	15W.	Clarance A. Cruzan	220.00	
Eagle Quartz Mine (Mt. Gleason)	31	4N.	12W.	B. F. Grant, 625 W. 41st Drive, Los Angeles	32.41	IX, p. 195; XI, p. 247; XII, p. 152; XIII, p. 204; XXIII, p. 293
Eagle Gold Mine	24	4N.	12W.	John J. O'Regan, Wm. P. Boland, et al., 421 Higgins Bldg., Los Angeles	25.66	
Elizabeth Placer, M. C.	15	4N.	13W.	E. S. D. A. Ames	159.38	
Emmed Pl. et al.	11, 12	4N.	16W.	Walberg Dozier Land Co.	40.00	
Enterprise et al.	28	5N.	14W.	Julius Dietzman, 828 S. Figueroa St., Los Angeles	112.266	
Ferguson Placer	27	2N.	9W.	Florence Ferguson	34.28	
Flishmeyer Mine	1	4N.	16W.	C. W. Flishmeyer, 1108 Magnolia St., Long Beach		
Gold Queen	30, 31 25, 36	4N. 4N.	11W. 12W.	John J. O'Regan, et al., 421 Higgins Bldg., Los Angeles, California	20.66	
Governor Quartz (New York)	22	5N.	13W.	Taken off Tax Records	60.00	IX, p. 192; XV, p. 476; XXIII, p. 294
Graham & Cecil	26	2N.	9W.	R. E. Branscomb, 3712 Revere Ave., Los Angeles	79.60	
Horse Shoe Cons.	5, 6 7, 8	2N. 2N.	8W. 8W.	San Gabriel Properties, M. A. Saunders, 201 Black Bldg., C. V. Brink, 1012 Terrace 49, Los Angeles, California	57.16	
Kaolin & Manzanita	27	4N.	14W.	R. C. Bufkin, 694 N. Los Robles, Pasadena	240.00	
Kelsey et al.	12	1N.	10W.	T. H. Knapp, c/o 120 W. Bennett Ave., Glendora, California	103.00	
Lap Wing et al.	28	3N.	14W.	Tessie Cook Haskins, 1320 Carroll Ave., Los Angeles, California	46.24	
Lodestone	11, 14 23	3N. 3N.	12W. 12W.	W. L. Baughman, 141 Ave. 30, Los Angeles	46.32	
Lone Cabin	6	3 .	14W.	Francis Larralde, 2231 Delmar Ave., Wilmar, California	20.00	

McAnany & Rice et al.	20, 28 29	3N. 3N.	14W. 14W.	Roger Goodan, 2440 N. Vermont Ave., Los Angeles	123.596	
Monte Cristo & M. S. Mount Gleason (see Eagle)	13	3N.	12W.	F. W. & Gertrude Carlisle, P.O. Box 53, Acton, California	25.66	XIII, p. 204; XXIII, p. 294
Nils Desperandum	5	3N.	15W.	N. D. Grant, 415 Citizens Nat'l Bank Bldg., Los Angeles, California	22.80	
Orange Blossom	14	4N.	14W.	Ira Judson Coe, Insurance Bldg., Los Angeles	80.00	
Orion	16	4N.	14W.	Rinaldo C. Bufkin, 694 N. Los Robles Ave., Pasadena, California	38.86	
Otto Mine	16	4N.	13W.	Paul J. Otto, 515 Citizens National Bank Bldg., Los Angeles, California	153.10	
Puritan Quartz	21	5N.	13W.	T. G. Shafer, I. L. Houser, Acton, Cal.	19.88	
Red Rover et al.	22	5N.	13W.	Taken off Tax Records	80.00	VIII, p. 333; IX, p. 201; XI, p. 246; XII, p. 153; XIII, p. 204; XXIII, p. 295
San Gabriel Mining	7, 8 17	2N. 2N.	8W. 8W.	San Gabriel Mining Corp., 717 Azusa Ave., Azusa, California	160.00	
Scorella Placers	1	4N.	16W.	Yucca Gold Mining Co. c/o P. G. Yondell on Jim Scorella Ranch	----------	
Soledad Mine	----------	-------	-------	Soledad Placer Co., 722 Washington Blvd., on the the Conroy Ranch., Los Angeles, California	----------	
Wrockloff Mine	----------	-------	-------	Mr. Wrockloff, 1224 Franklin St., Santa Monica, California	----------	

* Due to various legal complications which may arise regarding ownership of unpatented mining claims, we do not vouch for absolute correctness of this column. The names are mostly those appearing on the tax rolls. To save space, frequently only one of several owners is listed.

Helene Mine (Gold), comprising 60 acres of patented land, two miles north of Acton Junction and about 1½ miles southeast of the Governor Mine, is under lease to J. B. Ewald, on the ground. The property belongs to Miss MacLaughlin and Miss Montegrifo, of La Crescenta, California.

Here two roughly parallel quartz veins occur in the granitic country rock. They are approximately 20 ft. apart, strike N. 30° W., dip, at surface 60° NE. A shaft has been sunk on the footwall vein to a depth of 175 ft. At about 60 ft., a basic dike cut the vein and the shaft flattened to about 40°. It is planned to eventually crosscut both ways from the bottom of the shaft for the veins. It is reported that low-grade values have been encountered to date (up to $3 per ton).

The property is idle at present and equipment has been partially removed.

water-cooled blast furnace. The matte goes to a 5-ft. by 8-ft. modified reverberatory furnace to be used principally for driving off antimony. There is also a retort for removal of the gold from the lead matte, by zinc and a furnace for cupellation is to be built.

Mechanical equipment consists of 4 blowers driven by 10-h.p. oil engine.

Twelve men are employed.

IRON [1]

Titaniferous iron ores occur in Los Angeles county in the San Gabriel mountains, south of Soledad canyon. The known deposits occur in this range of mountains in a southeasterly direction from Sand Canyon to the headwaters of Tujunga River. The principal occurrences of titaniferous magnetite of this region are in T. 4 N., R. 14 W., on the ridge south of Soledad Canyon, extending easterly from Lang to Russ Siding on the Southern Pacific Railroad; also in T. 3 and 4 N., R. 12 and 13 W., in the area southwest of Mount Gleason and north of Tujunga Canyon, in the vicinity of Mill Creek and its tributaries.

These ores are associated with rocks of the gabbro family. The largest orebodies are found in rocks that are chiefly labradorite, in coarsely crystalline granitoid aggregates, known as anorthosites. The ore consists entirely of magnetite and ilmenite with but little visible gangue. Considerable experimental work has been done in the past, in an attempt to convert this material into commercial titanium products.

TITANIFEROUS IRON DEPOSITS

Mill Creek Deposits

Baughman Group, composed of 18 claims, is located 8 miles southeast of Acton, on both sides of Mill creek, a tributary of Tujunga canyon. Elevation 3700 ft. to 4500 ft. Owners, William Baughman and associates, of Los Angeles. Under lease and bond to E. I. de Nemours Dupont Company, Inc., Wilmington, Delaware.

Bibl: State Mineralogist's Report XXIII, pp. 296-297.

Lodestone Deposit is on both the east and west side of Mill creek, in NW¼ of Sec. 14, T. 3 N., R. 12 W. See also page 213.

The outcrops are from 5 ft. to 10 ft. wide and as much as 100 ft. in length. Some of them are said to carry as high as 18% ilmenite.

Bibl: State Mineralogist's Report XXIII, p. 297.

Condor Deposit is on the ridge between Coldwater canyon and the north fork of Tujunga canyon. The exposure of iron ore is 50 ft. long by 20 ft. wide and is said to carry 15% ilmenite and 40% magnetite.

Bibl: State Mineralogist's Report XXIII, p. 297.

Iron Mountain Group of 18 claims is on the north slope of Little Iron mountain, about 9 miles southeast of Acton. Elevation 4800 ft.

Several small outcrops of iron ore occur on these claims. No development work has been done.

Bibl: State Mineralogist's Report XXIII, p. 297.

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[1] For full description of the deposits of this area and a discussion of "The Utilization and Metallurgy of Titanium," reference should be made to State Mineralogist's Rept. XXIII, pp. 295-313.

Bryant Group of 3 claims is in T. 3 N., R. 13 W., S. B. B. M., on the south slope of Iron mountain, near the headwaters of Trail canyon. Small exposures of iron ore are found on these claims.

Bibl: State Mineralogist's Report XXIII, p. 297.

IRON DEPOSITS IN REGION SOUTH OF SOLEDAD CANYON

Iron Blossom Group, comprising 23 claims, is on a ridge between Pole and Bear canyons, one-half mile southeast of Lang, a station on the Southern Pacific Railroad. Elevation 3500 ft. Owners, Oliver Andreason and W. B. Allison (?), Los Angeles.

Formerly operated by *Mineral Increment Co.*, R. C. McInerny, president, Richmond, California.

Several outcrops of titaniferous iron occur near the top of the ridge. These exposures are 6 ft. to 8 ft. wide and from 30 ft. to 50 ft. in length. A large amount of high-grade float is found scattered over an extensive area. The country rock is gabbro and anorthosite.

About 150 ft. below the outcrop a tunnel has been driven east 300 ft. Several lenses of ore were encountered in the drift. The strike is E.-W., dip 45° N.

Equipment consists of No. 2 Wheeling crusher, 25-h.p. gas engine, 50-ton bin. There are 5 cottages and a garage on the property. Idle.

Bibl: State Mineralogist's Report XXIII, p. 297.

Iron Mack Mine is in Sec. 36, T. 6 N., R. 14 W., S. B. B. M., at the head of Mint canyon, about 10 miles north of Acton. The ore is low grade and limited in extent.

Bibl: State Mineralogist's Reports XV, p. 478; XXII, p. 297.

Needham and Boruff Group of 3 claims is in Sec. 31, T. 4 N., R. 14 W., S. B. B. and M., in Iron Canyon, 4 miles south of Lang. Owners, Fred Boruff and H. C. Needham, Newhall, California.

Bibl: State Mineralogist's Report XXIII, p. 298.

Russ Siding Deposit of titaniferous iron occurs within 200 yards of the Southern Pacific Railroad at this station.

Bibl: State Mineralogist's Reports XV, p. 478; XXIII, p. 298.

Burdick Minerals Corporation, F. F. Burdick, president; E. C. Carson, vice president; Willed Andrews, secretary. Offices, 330 Second St., Hermosa Beach, California.

This company experimented on the beach sands between Redondo and Palos Verde.

For description of their operation see State Mineralogist's Report XXIII, pp. 298-299.

LEAD-SILVER-ZINC

The occurrence of these metals in Los Angeles county is not abundant. The principal production has been from the deposits on Santa Catalina Island. Since they have been practically idle since the early part of 1928, only brief mention of the deposits is made here. For more complete information reference should be made to State Mineralogist's Report XXIII, pp. 32-38 and pp. 314-317.

Mines

Black Jack Mine is on the northeast slope of Black Jack mountain, 2 miles west of White's Landing and 14 miles by road northwest of Avalon, Santa Catalina Island. Elevation 1540 ft. Owner, Santa Catalina Island Co., Wm. Wrigley, president; D. M. Renton, vice president and general manager. Offices, Avalon, California.

Bibl: State Mineralogist's Reports X, pp. 279-280; XXIII, pp. 32-38.

Denver-Indicator Group (copper-lead-zinc). This group is in Pacoima canyon, 12 miles northeast of San Fernando. Elevation 2600 ft.

The ore is a complex sulphide, consisting of massive pyrrhotite, chalcopyrite, galena and sphalerite, carrying gold and silver values. Idle.

Bibl: State Mineralogist's Reports XVII, p. 318; XXIII, pp. 288 and 315.

Kelsey Mine (lead-silver). It is situated 5 miles north of Azusa, in T. 2 N., R. 9 W., S. B. B. M., in the Silver Mountain mining district. Elevation 3000 ft. It consists of 4 patented claims. Idle.

Bibl: State Mineralogist's Reports XI, p. 245; XXIII, pp. 315-316.

Lost Treasure Mine (silver) is situated 6 miles northeast of Azusa in San Gabriel canyon. Holdings comprise 4 claims.

Bibl: State Mineralogist's Report XVIII, p. 422.

Renton Vein Mine (lead-silver-zinc). It is located 2 miles southeast of Avalon, in Renton Canyon, on Santa Catalina Island. Elevation 700 ft. to 1100 ft. Owner, Santa Catalina Island Co., Wm. Wrigley, president; D. M. Renton, vice president and general manager.

Five parallel veins occur in andesite. They strike east and dip 60° north. They vary from 4 ft. to 6 ft. in width. The ore is sphalerite and galena carrying silver values. Metallic content, 8% to 12% zinc and 1½% to 2% lead. Idle.

Bibl: State Mineralogist's Report XXIII, pp. 36 and 316-317.

Quarry Mine (lead-silver-zinc). It is located on Santa Catalina Island west of the rock quarry, 1¼ miles southeast of Avalon and southwest of Pebble Beach. Elevation 300 ft. Owner, Santa Catalina Island Co., Wm. Wrigley, president. Idle.

A 130-ton flotation plant was built at White's Landing to treat ores from the Black Jack, Renton Vein and Quarry mines. This plant and the mines were shut down in the latter part of 1927.

Bibl: State Mineralogist's Report XXIII, pp. 36 and 316-317.

Silver King Mine (lead-silver) is in Texas canyon, 12 miles northeast of Saugus. Holdings comprise 18 claims. Elevation 2350 ft. Owner, W. H. Cruzan, Newhall, California.

Idle except for assessment work.

Bibl: State Mineralogist's Report XXIII, p. 317.

Sunshine Mine (gold-silver), consisting of 10 claims, is in Bouquet canyon, 17 miles from Saugus.

Here a shaft has been sunk 50 ft. on a quartz vein which is 20 ft. wide. Idle.

Bibl: State Mineralogist's Reports XVIII, p. 422; XXIII, p. 317.

Victoria Mine (lead-silver). It is located 6 miles northeast of Azusa, in San Gabriel Canyon. Elevation 3000 ft. Idle for years. Formerly operated by *Sierra Madre Silver Mining Co.*, Azusa, California.

Bibl: State Mineralogist's Report XI, p. 245.

MANGANESE

Amargosa Group of 9 claims, is situated 5 miles, by road, west of Palmdale in T. 6 N., R. 12 W. and R. 13 W., S. B. B. M.

Irregular lenses of manganese ore occur along siliceous outcrops in schist. They can be traced for a distance of several hundred feet. The width of ore exposed varies from 2 ft. to 5 ft. and it carries a high percentage of silica.

Developments consist of a number of open-cuts, short tunnels and shallow shafts. The deposit was worked by the *Llewellyn Iron Co.* in 1917. Idle.

Bibl: State Mineralogist's Reports XVII, p. 320; XXIII, pp. 317-318.

MICA

No commercial deposits of this material have been developed in the county. An attempt is now being made to commercialize a mica schist which is found in Little Tujunga canyon.

Independent American Mining Co., Room 701, 120 East Eighth Street, Los Angeles, has leased some claims from Frank X. Neher and C. W. Byrer, of Los Angeles. These claims are on the southeast side of Little Tujunga Canyon in Sec. 27, T. 3 N., R. 14 W., about 8 miles northeast of San Fernando. The leasing company is composed of Walter Rechstiener, Charles Peak and others.

Lenses of muscovite mica schist have been formed here along a shear zone in the granitic country rock. The strike of this zone is NW.-SE. and it dips steeply to the NE. Small lenses of schist of from one to 8 tons each have been found in three small open-cuts on the southeast side of the canyon.

A plant has been built near the bottom of the canyon, consisting of the following:

Ten-ton bin to small hammer mill to 15-ton bin to 15 inch diam. cast worm 16 ft. long. Around this worm two brick furnaces equipped with oil burners have been built. They are 7 ft. long, 4 ft. 6 in. high by 4 ft. wide. A temperature of 1800° is reached in these furnaces.

The ground schist of various shades of green to bronze color, all burns to a uniform bronze shade.

The products are from 40 to 80 mesh but it is proposed to reduce these to 200 mesh. Two tons have been sold to paint manufacturers.

Idle.

Nora-Evelyn Group of Claims (vermiculite), comprising 7 claims, is in Sec. 19, T. 4 N., R. 14 W., about 8 miles west of Acton, on a

ridge south of Soledad Canyon. Elevation 3700 ft. Owners, Robert Elliott, 3430 Montrose Ave. and E. O. King, 3337 Honolulu Ave., La Crescenta, California.

The rocks of this area consist very largely of labradorite, in which are found dikes of quartz-diorite. In the main mass of this dazzlingly white rock, practically no quartz or mica is visible, but associated with the diorite dikes, occasionally is found a segregation of hydrous mica of the vermiculite group. From present exposures, the jefferisite form seems to predominate near the north end of the deposits while another phase is found on the south end. The trend or strike of these deposits is N. 30° E., dip approximately 45° NW. Evidence of the existence of lenses has been found over a length of some 1500 feet.

The principal exposure is shown in a hillside cut about 150 yards north of the Forestry Department road which goes from Indian creek across to Pasadena. In this cut the deposit has a width of about 15 ft. Near the surface the material is distinctly laminated and of a dirty brown color which it is said burns to a golden hue. With a little depth, it becomes tougher and more massive, which material burns to a silvery color.

There are visible two or three parallel zones along which lenses of this material might be found.

The owners plan to open the deposits in the immediate future.

MOLYBDENUM

Manzanita Mine, comprising 2 claims, is in Lang canyon, in T. 2 N., R. 12 W., S. B. B. M., 6 miles north of Altadena. Elevation 3500 ft.

Molybdenite is found here associated with copper in a quartz vein which occurs in granite. Idle.

Bibl: State Mineralogist's Report XXIII, p. 318.

NONMETALLIC MINERALS

The production of nonmetallic minerals in Los Angeles county has fallen from more than $11,000,000 in 1926, to $2,394,000 in 1934. This decrease has been entirely due to cessation of building activities during the depression.

BARITE

San Dimas Barite Deposit is 8 miles northwest of San Dimas, in Sec. 23, T. 1 N., R. 9 W., on the west fork of San Dimas canyon.

An outcrop of barite occurs on the west side of the canyon. The general strike is northeast with a slight dip to the southeast. The outcrop is about 50 ft. in length and from 6 ft. to 8 ft. wide. The material is white and is said to be 85% barium sulphate. Idle.

Bibl: State Mineralogist's Report XVII, p. 317.

BORAX

There was a large deposit of colemanite in Los Angeles county, 5 miles north of Lang in Tick Canyon. Elevation 2300 ft. It was formerly worked by the *Sterling Borax Co.*, of Los Angeles, but has

now been shut down for several years and all equipment has been removed from the property. Presumably the profitable material has all been extracted.

The colemanite beds strike east and dip 70° to 80° south. They occur interbedded with clay-shale which, in places, is covered with a flow of andesite. The colemanite beds are from 30 ft. to 50 ft. thick. The deposit was worked through a vertcial shaft and evidently was mined for several thousand feet in length. The calcium borate was formerly transported by narrow-gauge railroad to Lang, a station on the Southern Pacific Railroad. This road has been torn up.

Bibl: State Mineralogist's Report XV, pp. 480-481.

CLAYS

There are no known deposits of high-grade clays in Los Angeles county but throughout its area there are clays mixed with sand and containing numerous inclusions of pebbles which are suitable for the manufacture of common brick and tile. High-grade clays used in the county are shipped in from Amador, Placer, Riverside and San Diego counties.

No description of the deposits or manufacturing plants will be attempted in this report as this subject has been thoroughly covered in Bulletin 99, "Clay Resources and Ceramic Industry of California," prepared by Prof. W. F. Dietrich, of Stanford University, and published by the State Division of Mines in 1928.

DIATOMACEOUS EARTH

There are deposits of this important material in Los Angeles County but to date there have been only two which have been developed and made to produce commercially.

The Dicalite Co., C. A. Frankenhoff, president, New York; local offices 756 S. Broadway, Los Angeles, has leased 1000 acres on the northeast slope of the Palos Verdes Hills, between Redondo Beach and San Pedro. Owner, Palos Verde Corp., A. L. Grossman, vice president, is coast manager for the company, and M. Stockton is superintendent.

This deposit, varying in thickness, occurs interbedded with clay. The strike of the deposit is NW.-SE. and the general dip which is quite flat is to the northeast. The thickness of the clay overburden, as removed from various openings, is from practically nothing to about 10 feet. Quarries have been opened on eight separate hills and in each instance points of attack have been chosen so that the dip of the beds conforms to the slope of the hillside which places would have a minimum amount of overburden. The beds of diatomaceous earth gradually pass into material too low-grade to work, on both top and bottom. Bank run of the material carries 50% moisture.

The stripping is done on contract by two 1½-yd. shovels. The mining is done by hand in order to avoid dilution. It is loaded into wagons and hauled to a stock pit where it is dried to 20% moisture. It is then loaded into trucks, by hand, and hauled one-half mile to the plant.

The plant consists of bin, belt conveyor to swing hammer mill, to 2 silos, 18 ft. by 40 ft., to fans which also mill the material, to drying

tubes, to cyclone system, thence to 9 ft. by 100 ft. kiln, temperature 1400° to 2000° F., fan to packing collectors. Maximum size is minus 200 mesh and most of it will pass through 325 mesh. Capacity 100 tons.

Products are used as absorbents, abrasives and for filtering.

Employs 120 men.

Featherstone Insulation Company's Deposit is on the north slope of the San Jose Hills, 2½ miles east of Covina, in T. 1 S., R. 9 W., S. B. B. M. Elevation 750 ft. Their holdings comprise 500 acres. Owner, The Featherstone Co., former address, 911 Mateo St., Los Angeles. Robert Burham, Jr., president.

The deposit, plant and its operation are fully described in our Report XXIII, pp. 319-321.

It has been idle for some years.

Santa Catalina Island Deposits. Beds of diatomaceous earth, said to be 75 ft. in thickness, occur on the island.

Other deposits occur in the *Santa Monica Mountains*, the most extensive exposures being near Point Durma, northwest of Santa Monica.

Bibl: State Mineralogist's Reports XII, p. 406; XIII, p. 643; Bull. 38, p. 363.

DOLOMITE

Deposits of dolomite occur on the west slope of the San Gabriel mountains in Sec. 13, 17, T. 3 N., R. 15 W. and in Sec. 7 and 18, T. 3 N., R. 14 W., S. B. B. M., between Pacoima canyon and Grapevine canyon, north of San Fernando.

Baughman Dolomite Deposit is in Sec. 7 and 18, T. 3 N., R. 14 W., S. B. B. M., on a ridge north of Pacoima creek, 5 miles north of San Fernando. Elevation 3000 ft. Owner, Will Baughman, Los Angeles.

A belt of white, crystalline dolomite occurs in the granite. It strikes east and dips 50° north. The exposure is about 300 ft. in width and some 3000 ft. in length.

Haskins Dolomite Deposit comprises 5 claims and mill site in Sec. 28, T. 3 N., R. 14 W., S. B. B. M., on slope of ridge northeast of Little Tujunga canyon, 3½ miles north of Sunland and 5½ miles northeast of San Fernando. Elevation 2000 ft. to 2700 ft. Owner, Mrs. Tessie Cooke Haskins, 268 Burlington Ave., Los Angeles.

A series of lenses of dolomite occurs in the gneissoid granite. They are from 30 ft. to 40 ft. thick and from 100 ft. to 200 ft. in length. They strike N. 30° W. and form prominent outcrops on the east and west sides of Limestone canyon.

The property has been developed by a series of open-cuts or quarries.

Quarry No. 1 is on the Lady Helen claim near its south end line about 100 ft. above the floor of Limestone canyon. The quarry face is some 50 ft. in length and has been opened on a lens of dolomite which is about 150 ft. long.

Quarry No. 2 is just northeast of Limestone canyon. Here is exposed a lens of dolomite 20 ft. thick and 40 ft. in length.

Analysis by Baverstock and Payne, of Los Angeles:

Calcium oxide, CaO	32.75%
Calcium Carbonate $\left\{\begin{matrix}CaCO_3 \\ \text{equivalent}\end{matrix}\right\}$	58.20%
Magnesium oxide, MgO	17.20%
Magnesium carbonate (equivalent)	36.00%

Another analysis from an open-cut on the Lapwing claim by the same chemists:

Calcium oxide, CaO	49.3%
Calcium carbonate, $CaCO_3$ (equivalent)	87.8%
Magnesium oxide, MgO	4.0%
Magnesium carbonate, $MgCO_3$ (equivalent)	8.4%

On the Lone Jack claim there is a massive out-crop some 200 ft. in length and 50 ft. thick. This is exposed by an open-cut across 50 ft.

From the exposures and analyses, a substantial tonnage of commercial material should be available on this ground.

Ramelli Dolomite Deposit is on the west slope of the San Gabriel mountains, in Sec. 17, T. 3 N., R. 15 W., S. B. B. M., 4 miles northeast of San Fernando. Elevation 2200 ft. Holdings comprise two claims, approximately 40 acres. Owners, Frank Ramelli and Edward Oviatt, Van Nuys, California.

White, crystalline dolomite occurs in granite with a generally east-west strike and dip of 45° to the north. The exposure is from 200 ft. to 500 ft. in width and can be traced for the full length of two claims.

Bibl: State Mineralogist's Report XIX, p. 165.

San Fernando Company's Dolomite Deposit is located in Sec. 13, T. 3 N., R. 15 W., S. B. B. M., 4 miles north of San Fernando and on a ridge east of Pacoima canyon. Elevation 300 ft.

The exposure of dolomite is several hundred feet wide and 200 ft. in length. It occurs in granite with an easterly strike and a northerly dip.

Bibl: State Mineralogist's Report XXIII, p. 322.

FELDSPAR AND SILICA

In the past five or six years there has been little development of these minerals in the county due to depressed market conditions.

There is an extensive belt of labradorite, lime-soda feldspar, containing a high aluminum content that extends east from Lang on both sides of Soledad canyon to Ravenna, a distance of about 12 miles.

Following is an analysis of this rock by the C. W. Hill Co., of Los Angeles:

Silica	58.10%
Alumina	28.27%
Ferric oxide	1.03%
Lime	8.60%
Magnesia	0.54%
Potash	1.60%
Soda	0.82%
Moisture	0.10%
Loss by ignition	0.55%
	99.61%

Silica occurs quite abundantly in the county and a number of quartz out-crops in the vicinity of Acton have been worked in the past, although none recently. For this reason the deposits are only briefly mentioned here. For more complete data reference should be made to State Mineralogist's Report XXIII, pp. 322-325.

Deposits

Caliproducts Company's Deposit (feldspar-silica). It is located in Sec. 15, T. 4 N., R. 13 W., S. B. B. M., one mile south of Ravenna, a station on the Southern Pacific Railroad. Elevation 2650 ft. Holdings comprise 200 acres. Owner, Leonardo Ruiz, Acton, California.

The property was developed by short tunnels and a 100-ton grinding plant built on the ground. Idle.

Bibl: State Mineralogist's Report XXIII, p. 323.

Chicago-Pacific Deposit (feldspar and silica). This deposit is located in Sec. 8, 9, 15 and 17, T. 4 N., R. 14 W., S. B. B. M., 11 miles east of Saugus, and one-quarter of a mile north of Lang, a station on the Southern Pacific Railroad. Comprises 13 claims. Owners, J. P. Monahan and J. G. Krown, Los Angeles.

Bibl: State Mineralogist's Report XXIII, pp. 323-324.

Duncan Deposit (feldspar-silica). Consisting of 160 acres of patented land, this deposit is located in Sec. 14 and 15, T. 4 N., R. 13 W., S. B. B. M., one mile south of Ravenna, a station on the Southern Pacific Railroad. Owner, Harry Duncan, Los Angeles.

Bibl: State Mineralogist's Report XXIII, p. 324.

Gates Chemical Company's Deposit (feldspar-silica). This deposit of labradorite (lime-soda-feldspar) is located near Alpine Siding, on the Southern Pacific Railroad, in Soledad canyon, 2 miles east of Lang. Elevation 1950 ft. Holdings consist of 7 claims in Sec. 15, T. 4 N., R. 14 W., S. B. B. M. Owner, Gates Chemical Co., Denver, Colorado.

Bibl: State Mineralogist's Report XXIII, p. 324.

Stanley Alumina-Silicate Deposit (feldspar and silica). It is in Sec. 26 and 28, T. 4 N., R. 14 W., S. B. B. M., 4 miles southeast of Lang. Elevation 3000 ft. Comprises 160 acres. Owner, George Stanley, Los Angeles.

Silica Mining and Products Company's Deposit (feldspar-silica). It is located one-half mile northeast of Acton, a station on the Southern Pacific Railroad. It consists of two claims. Elevation 3200 ft. Owner, Silica Mining and Products Co., Los Angeles.

Bibl: State Mineralogist's Report XXIII, pp. 324-325.

GRAPHITE

Commercial deposits of crystalline graphite occur in Los Angeles County in Kagel canyon, east of Fernando, in San Francisquito canyon, 18 miles northeast of Saugus and in the Verdugo Hills, 2½ miles northwest of Montrose. In these deposits the graphite occurs in crystalline flakes disseminated through a schist. According to E. S. Bastin, of the United States Geological Survey, the percentage of graphite in the California deposits appears to be nearly twice that of the eastern

deposits of flake graphite which are located in New York, Pennsylvania and Alabama. The flakes in the California graphitic schist are much smaller than those in the eastern states, most of them not exceeding 0.25 millimeter in diameter. Some production has been made from all of the deposits mentioned but considerable difficulty has been encountered in making a complete separation of the graphite from the gangue materials. None of the deposits are being operated at this time.

Gilman Graphite Deposit is in Pacoima and Little Tujunga canyons, in Sec. 17, T. 3 N., R. 15 W., 2¼ miles northeast of Pacoima canyon dam and 5 miles northeast of San Fernando. Owner, M. R. Gilman, 504 West Avenue 37, Los Angeles.

A road cut here exposes several lenses of crystalline graphite from 2 ft. to 4 ft. wide. Strike E.-W., dip 40° S. There has been no development work.

Kagel Canyon Graphite Deposit is on the western slope of the San Gabriel mountains, in Kagel canyon, 8 miles east of San Fernando. Holdings comprise 5 claims. Elevation 2400 ft.

There was a 50-ton concentrating plant on this property.

Bibl: State Mineralogist's Reports XXIII, p. 325; XVII, p. 318.

San Francisquito Canyon Graphite Deposit is in Sec. 11 and 12, T. 6. N., R. 15 W., S. B. B. M., 18 miles northeast of Saugus, in a branch of San Francisquito canyon. Holdings comprise 9 claims. Owner, California Graphite Co. (?), Los Angeles. It has not been operated for several years.

Bibl: State Mineralogist's Reports XV, pp. 501-504; XVII, pp. 318-319; XXIII, pp. 325-326.

Verdugo Mountain Graphite Deposit is situated 12 miles northeast of Los Angeles and 2½ miles northwest of Montrose, in Sec. 29, T. 2 N., R. 13 W., S. B. B. M., on the Hostetter Ranch. Elevation 1500 ft. Owner, J. E. Hostetter, Los Angeles. Was under lease to *Standard Graphite Co.*, Glendale, California.

A flotation plant was erected on the ground. Idle.

Bibl: State Mineralogist's Reports XV, p. 504; XVII, p. 319; XXIII, p. 326.

Western Graphite Company, C. W. Jones, president, 337 West Avenue 26, Los Angeles, built a plant for the treatment of a graphite deposit two miles south of Lake Hughes. This plant was put into operation in November, 1934 and ran intermittently until the latter part of 1935. It was then converted into a custom plant for gold ores and its operation as such is described under gold.

GYPSUM

While deposits of this material occur in the county near Palmdale, and Lang, in Sec. 30, T. 5 N., R. 14 W., S. B. B. M. and at the head of San Francisquito creek, 13 miles from Casteca, there has been no commercial production in recent years.

Bibl: State Mineralogist's Reports XI, p. 248; XII, p. 324; XIII, p. 504; XV, pp. 504-506; XXIII, p. 327; Bull. 38, pp. 284-286.

LIME

Fossiliferous deposits of lime occur in the San Pedro Hills on the Palos Verdes Ranch, between San Pedro and Redondo Beach.

Torrance Lime and Fertilizer Co., Frank Samons, president; Richard C. Kite, secretary, operated in the D. M. S. and B. fossil beds which are located on the east slope of the San Pedro Hills, two miles southwest of Lomita. Idle.

Bibl: State Mineralogist's Report XXIII, p. 328.

MINERAL WATER

There are a number of mineral springs in Los Angeles County, some of which are within the city limits of Los Angeles.

Bimini Springs are located at Bimini Street and Vermont Avenue. Owner, Bimini Water Co. It is used for baths and bottled for sale.

Holly Springs Water Co., 2284 Holly Drive; *Hollywood Medical Springs*, 5633 Melrose Avenue; *Magnetic Spring Water Co.*, 936 Palm Avenue, Sherman, California.

Mohn Mineral Springs, located in Topango Canyon, 10 miles northwest of Santa Monica. Owner, Mohn Mineral Springs Co., 6253 Hollywood, California. Water bottled for sale.

Mountain Spring Water Co., 226 South Avenue 54, Los Angeles. Water bottled for sale.

Rose Spring Mineral Water Co., 4835 Pasadena Avenue. The spring is located on Pasadena Avenue, opposite Sycamore Park. Water bottled for sale.

MINERAL PAINT

Deposits of red and yellow ochre occur on Santa Catalina Island. These deposits are being developed for commercial use by the Santa Catalina Island Co. The principal occurrence is found along the surface outcrops of veins that are being worked for lead-silver and zinc in Renton canyon.

SOAPSTONE AND TALC

Deposits of soapstone and talc occur in chloritic schist on both sides of Bouquet canyon, 13 miles west of Palmdale and 16 miles northeast of Saugus, a station on the Southern Pacific Railroad. A considerable amount of surface prospecting has been done on these deposits but no commercial production has been made in recent years.

For description of the different deposits see page 321 of Report XVII of the State Mineralogist.

There is also an extensive deposit of steatite on Santa Catalina Island, located near the isthmus, at Empire Landing.

SALT

There is no source of salt in Los Angeles County except the water of the Pacific Ocean, from which it is extracted by solar evaporation west of Long Beach. At present there is only one plant in operation in the county.

Long Beach Salt Company, H. G. Fenton, president; B. S. Hardy, secretary; O. L. Huffine, superintendent. Offices, No. 1 Drumm Street, San Francisco.

The plant is situated one-half mile south of Anaheim Road, between Wilmington and Long Beach. The pond area amounts to 250 acres which has been divided into shallow ponds for evaporation by the construction of low dams. The water is pumped in from the ocean to the evaporating ponds, from which it flows to twenty crystallizing ponds (200 ft. wide by 250 ft. in length by 24 in. in depth). In these crystallizing ponds the salt begins to crystallize out and at 1.252 specific gravity salt of the first quality is deposited, after which the remaining brine known as bittern water is pumped off, new brine from the evaporating ponds is transferred into the crystallizing ponds and thus the process continues until the salt deposit reaches a depth of 6 inches. When the desired thickness of salt has been deposited, the pond is drained and a crew of men set to work to harvest the salt. The crystallizing season runs from April 1 to July 1 and the gathering season from September 1 to January 1. The method of harvesting consists of a narrow launder 250 ft. in length, containing a screw conveyor, and six men shovel salt into the launder, where it is washed with fresh salt water. The salt is conveyed by screw conveyor to a belt stacking machine which distributes it into piles along the railroad track. From stock piles the crude salt is loaded into a car having a capacity of 5 tons, in which it is transported to the plant. Here the salt is dumped into a hopper, from which it is conveyed by bucket elevator to screens. The screened salt goes to 4 conical dryers, then elevated to screens, the oversize from these screens going to bins for use as packing salt. The through-size goes to a set of rolls for grinding for table salt. The very coarse salt is used by the packing companies. It also is used in the manufacture of ice cream and in various forms of business in which coarse salt is necessary. The present production is about 10,000 tons per year.

COMMERCIAL GRINDING PLANTS

There are seven commercial grinding plants in Los Angeles County. A list of these is as follows:

American Minerals, Inc., 2808 S. Pacific Ave., San Pedro, Calif.; *California Talc, Inc.*, 837 Jackson St., Los Angeles; *Chamberlain Co.*, 2550 E. Olympic Blvd., Los Angeles; *Hill Brothers Chemical Co.*, 2159 Bay St., Los Angeles; *Los Angeles Chemical Co.*, 1960 Santa Fe Ave., Los Angeles; *Pacific Coast Talc Co.*, 2149 Bay St., Los Angeles; *Sierra Minerals, Inc.*, 1557 Courtney, Los Angeles; *Western Talc Co.*, 1901 E. Slauson Ave., Los Angeles.

Description of each of these plants will be found in our report XXVI, pp. 340-345, with the exception of the two described below.

American Minerals, Inc., 2808 S. Pacific Ave., San Pedro, California, has leased the plant formerly operated by the American Potash & Chemical Co. Jos. A. Stanko is president of the company and Dr. J. J. Stanko is in charge of the plant.

Their products consist of chinaware, tile, sanitary ware, electrical porcelains and roofing granules. These are all made from a rhyolite shipped in from Mojave.

The material is ground wet in two 6 ft. by 22 ft. ball mills and dewatered by two Patterson plate filters. The wet slurry is colored, dehydrated and vitrified for manufacture of the roofing granules.

The process is a patented one which the company does not wish to make public at this time. Capacity of the plant is 50 tons per day. Sixty men are employed.

Sierra Minerals, Inc., 2447 E. 57 St., Los Angeles; A. Morris Sides, president; John B. Illo, manager.

This company also operates a plant at Le Grand, California.

STONE INDUSTRY

For information concerning the stone industry in Los Angeles County the reader is referred to State Mineralogist's Report XXIII, pp. 330-345.

Roscoe Plant
Consolidated Rock Products Company

This caption includes granite, sandstone, serpentine, schist and greenstone, slate roofing material, trachyte, crushed stone, gravel and sand.

All of these industries except gravel and sand, have been practically dead for the past seven years.

SAND AND GRAVEL AND CRUSHED STONE

This important industry which, in 1926 had reached a peak of production valued at $7,472,884, has gradually declined until in 1934 its value was $1,220,639. Due to activity in building in 1935 it increased to $1,135,068 and in 1936 the value jumped to $8,542,619, about half this increase being due to construction of San Gabriel Dam.

In 1934 there were 26 companies producing crushed rock and/or sand and gravel in the county. Of these, three companies are the principal producers: *Consolidated Rock Products Co., Blue Diamond Co.* and *Graham Brothers, Inc.*

For description of some of the principal plants and the areas in which they are located reference may be made to State Mineralogist's Report XXIII, pp. 333-345.

PETROLEUM

By Emil Huguenin*

The past year was characterized by three important developments in the oil fields in Los Angeles County:

(1) The discovery of a new field at Wilmington.
(2) The completion of a large well at El Segundo, definitely proving it to be an important field and
(3) The extension of the proved area of the Torrance field to the northwest.

Although fewer wells were actually drilled in 1936 than in 1935, 288 notices to drill having been filed, as compared with 371 in 1935, drilling was largely spread over most of the Los Angeles Basin fields. The almost complete cessation of new well drilling at Long Beach accounts for the fewer wells drilled in this district, only 12 new wells having been drilled in this field this year as against 142 last year. Over twice the number of wildcat wells drilled in 1935 were drilled in 1936 showing the intensive search for new pools. Of the numerous wildcat wells drilled, first in importance in point of discovery was General Petroleum Corp. of California well No. "Terminal" 1, discoverer of the Wilmington oil field. Drilled to a depth of 6784 ft. this well penetrated the basement complex (schist) at that depth. Three definite oil zones were penetrated in the drilling of this well—the first generally referred to as the Tar zone from 2450 ft. to 2700 ft., the main productive or Terminal zone 3150 ft. to 3650 ft. and the deep zone 5300 ft. to 5500 ft. After testing both the Tar and Deep zones, the well was completed on December 6, flowing at a rate of 1600 barrels 20° gravity clean oil, from the Terminal zone.

Next in importance was the completion of Richfield Oil Corp. well No. "El Segundo" 1, Sec. 18, T. 3 S., R. 14 W., located about one-fourth of a mile southwest of the discovery well, Republic Petroleum Co., "Republic El Segundo" 1. While the discovery well came in flowing at a rate of but 400 barrels daily, the Richfield well was completed for 2600 barrels clean oil and about one and one-half million cubic feet of gas.

Completion of Dumas-Lewis Oil Co. well No. "Dumas Lewis" 1, Sec. 6, T. 4 S., R. 14 W., located approximately 1700 ft. beyond the northwest limits of the Torrance oil field, resulted in a fairly intensive leasing and drilling campaign, which accounts for the large number of new wells drilled in the Torrance field this year. Practically all of these wells are located in the Redondo area.

Another completion of lesser importance was that of Twentieth Century Oil Co. well No. "Schaaf Bruce" 1, Sec. 36, T. 5 S., R. 11 W., located approximately a mile beyond the northeast edge of the old

* Deputy State Oil & Gas Supervisor, Los Angeles Office, Division of Oil and Gas.

Huntington Beach field. This well, originally drilled by Calnan Oil Co. in 1927 to a depth of 4500 ft., was later taken over by C. J. Miley and deepened to 5117 ft. No sands thought to be worthy of test were encountered and operations were suspended in December, 1927. Twentieth Century Oil Co. entered the old hole in January of this year and deepened it to 5170 ft. After making electrical surveys and taking a few side hole cores the hole was plugged back to 4490 ft. and a 7-in. casing cemented at 4437 ft. On a production test it was wet. It was then replugged to a higher level, leaving only 14 ft. of formations exposed. The well was then put on the pump and has been producing since at a daily rate, varying from 40 to 100 barrels 13° to 14° gravity oil, cutting 10% to 40%. Correlations indicate that the producing zone is probably a stringer of sand in the intermediate Ashton zone.

Other wildcat wells drilled during the year which attracted attention but which were abandoned or suspended after failing to find productive sands are:

Vance Development Co., Ltd., well No. "Millard" 1, Sec. 25, T. 3 S., R. 12 W., located near Artesia; drilled to a depth of 5818 ft. Eastern Oil Co. well No. "Eastern" 1, Sec. 22, T. 2 S., R. 15 W., located a mile east of the old Playa del Rey field, was drilled to a total depth of 7420 ft. The Superior Oil Co. drilled and abandoned the deepest well ever to be drilled in the Los Angeles Basin, namely "Inglewood Extension" 1, Sec. 25, T. 2 S., R. 15 W. Located about midway between Inglewood and Playa del Rey oil fields it was drilled to a depth of 9426 ft., encountering a few thin streaks of oil sand below a depth of 8000 ft. It was abandoned after formation tests yielded negative results.

As is usually the case the large majority of wells abandoned during the year were started prior to 1936, 75 per cent of them being in the town-lot fields of Huntington Beach, Long Beach, Playa del Rey and Santa Fe Springs.

Dominguez

In 1936 Shell Oil Co. drilled 4 new wells and deepened one to the Miocene production on the southwest flank of the structure. The production from these wells averaged, during the first 30 days, 500 barrels per day or less. Union Oil Co. of California completed 8 new wells in the "Callender" lease and recompleted one. Half of the new wells drilled during the year were completed in the Miocene zones. The best producer, well No. "Callender" 42, flowed over 2900 barrels of oil per day from this formation between 6747 ft. and 7560 ft. The initial production of the other three wells completed in the Miocene, averaged about 800 barrels per day. Two wells completed in the Third Callender zone averaged 300 barrels per day, while 400 barrels per day was the initial production of two wells completed in the Fifth Callender zone above 5441 ft.

On the "Hellman" lease, 4 new wells were drilled and one recompleted. The only Miocene completion on the lease during the year, well No. "Hellman" 42, was brought in at the end of the year for approximately 1000 barrels per day of 25.5° A. P. I. oil. The other three wells were bottomed in the shallower zones and produced initially

under 500 barrels per day each. Well No. "Hellman" 30, a deep test, drilled to 7893 ft. in 1935, was plugged back to the Third Callender zone and is producing less than 100 barrels per day.

On the "Carson" lease well No. "Carson" 6 was recompleted at the first of the year, producing over 1200 barrels per day from the zone 6638 ft. to 7010 ft., while well No. "Carson" 8 completed in October, producing from the zone 7210-7405, flowed only 450 barrels of 29.9° A. P. I. per day.

At the end of the year only 7 wells were being drilled in the field, among them being Union Oil Co. of California well No. "Callender" 50, a deep test which had been carried below 8500 ft.

During the year, West American Oil Co. drilled a deep test well No. "Del Amo" 1, in Sec. 3, T. 4 S., R. 13 W., to the total depth of 9288 ft. While oil sands were encountered in the well, none appeared to be completely oil-saturated. The well was abandoned on September 12, 1936.

El Segundo

After completing well No. "Republic-El Segundo" 1, Sec. 18, T. 3 S., R. 14 W., on August 24, 1935, Republic Petroleum Co. drilled its second well, "Republic-El Segundo" 2, approximately 500 ft. to the northwest, encountering slightly more productive zone than in the original well. This second well was completed 'barefoot' on May 3, 1936, producing about 500 barrels per day of 26° A. P. I. oil. Five days later the production had declined to 340 barrels per day. Offsetting this second Republic well to the north, Ohio Oil Co. drilled well No. "Gough" 1, Sec. 7, T. 3 S., R. 14 W. Penetrating about 25 ft. of oil zone the well produced only 160 barrels per day on completion, September 1, 1936. Richfield Oil Corp. well No. 1, Sec. 18, T. 3 S., R. 14 W., located approximately 1400 ft. southeast of the original Republic well, penetrated over 100 ft. of well-saturated conglomerate and oil sand. This well, on completion, December 7, 1936, produced over 2500 barrels per day of 27.2° A. P. I. oil and 1590 Mcf. of wet gas. Pressures of 1400 lb. and 95 lb. per square inch were recorded on the casing and tubing respectively. At the end of the year the well was producing nearly 1900 barrels per day.

From the completions to date, it appears that the accumulation will extend along the regional NW.-SE. trend but individual locations may vary greatly in the thickness of producing formations encountered. Three new wells were being drilled and several locations had been staked in this new field by December 31, 1936.

Inglewood

Development at Inglewood continued slowly apace during 1936, only 15 wells being drilled. The two completions of Kettleman & Inglewood Corp. on the "Rubel" lease averaged on tests, nearly 2750 barrels per day from the Rubel zone below 3300 ft. This operator's two completions in the "Cone" lease however, were not better than 550 barrels per day. Shell Oil Co. drilled only 4 wells, the best producer being "Rindge" 20, completed on June 9, 1936, with an initial daily production of over 2100 barrels of 32.5° A. P. I. oil. Four wells were also drilled by Standard Oil Co. of California in the "L. A. Invest-

ment'' lease. Well No. ''L. A. Investment Lease'' 78, when tested for potential produced nearly 3800 barrels during a 24-hr. test, being completed on June 27, 1936. Two 500-barrel producers were completed by Standard Oil Co. of California on the ''Vickers 1'' lease. Tide Water Associated Oil Co. well No. ''Vickers'' 51, the operator's only new well in this field, also was completed producing nearly 500 barrels per day.

Montebello

Montebello was very active during the year. Twenty-five new wells were drilled, 13 in the East Montebello area, 7 on the Standard Oil Co. of California, Baldwin lease and 5 on the St. Helens Petroleum Co., Ltd., Monterey lease, which is located in the extreme west end of the field. Several outstanding well completions were made in the East Montebello area. Richfield Oil Corp. well No. ''Nutt'' 1 was completed in June at the initial daily rate of nearly 3300 barrels of 39.0° gravity oil and 3500 Mcf. gas from a depth of 5900 ft., taking in the entire Nutt zone.

Although many wells in this area showed a high initial production, the decline was usually very rapid showing a definite decrease day to day. The limits of the field have been well-defined except possibly to the northwest on The Texas Co., Baldwin lease. The southerly limit for the Farmer and Baldwin zones was definitely determined in the Universal Consolidated Oil Co. well No. ''Pasadena'' 2.

The deepest well in the field was drilled by Standard Oil Co. of California—its well No. ''Baldwin'' 82. This well reached a depth of 9334 ft. but encountered nothing of interest below the known shallow zones. It was plugged back and completed in the upper horizon.

The St. Helens Petroleum Co., Ltd., drilled and completed 5 wells on its Monterey lease, averaging slightly over 100 barrels of oil per well per day. These wells were all completed in the second zone, which is the first productive zone in this area and extends approximately between the depths of 3450 and 3800 ft. This is the first new development that has taken place in this section of the field for a number of years.

Rosecrans

This field received scant attention during the past year. Barnsdall Oil Co. deepened well No. ''O'Dea'' 15, Sec. 18, T. 3 S., R. 13 W., to 6395 ft. and recompleted it on July 31, 1936, producing 150 barrels per day of 37.1° A. P. I. oil. This well, producing from the formations between 6373 ft. and 6140 ft. penetrated to the base of Pliocene sediments.

Santa Fe Springs

New wells drilled during the year numbered 21, as compared with 33 drilled the previous year. This drilling was principally due to lease requirements and not to new discoveries. The majority of the new wells were completed in the Bell and Meyer zones. In addition to the new drilling, repair and abandonment work continued at about the same rate as in the previous year.

Torrance

After the completion of Seaboard Royalties Co., Ltd. (Thomas R. Clark) well No. ''Clark'' 1, Sec. 6, T. 4 S., R. 14 W., in the Redondo

area, at the end of 1935, considerable interest developed and as a result a total of 41 wells were drilled into this undrained portion of the Torrance structure. Dumas-Lewis Oil Co. completed the next well, "Dumas-Lewis" 1, Sec. 6, T. 4 S., R. 14 W., on March 6, 1936, producing initially nearly 400 barrels per day of 18.0° A. P. I. gravity oil. Offset and neighboring wells were completed producing between 150-200 barrels per day and it soon became apparent that similar to the older portions of Torrance oil field, a rapid production decline was to be expected. At the end of the year the activity had entirely subsided and only a few wells were producing at the hundred-barrel per day rate.

Five wells were drilled during the year 1936 to the conglomerate zone overlying the basement complex. None of these wells obtained anything other than hot sulphur water with a showing of oil and gas.

On November 30, 1936, Dearborn Oil Co. recompleted well No. "Flint" 1, Sec. 16, T. 4 S., R. 14 W., flowing about 400 barrels per day of 26° A. P. I. oil from the intermediate zone between 4300 ft. and 4550 ft. A flowing well in the field created somewhat of a stir and at the end of the year four offsetting wells were being drilled.

TITANIFEROUS IRON

(Additional Notes—See also p. 196)

The E. I. Dupont Co. has taken a lease and option on some 33 claims in the Mill Creek area. Of these claims, 27 belong to F. W. Carlisle, Box 7, Palmdale, California, and 6 belong to William Baughman and associates, of Los Angeles. The company also has a crew of men locating additional claims.

The field work to date has consisted of magnetometer surveys and the area under consideration lies between Lynx Gulch on the west, Mill Creek on the east, the Monte Cristo Mine on the north and Tujunga Creek on the south. It is intended to begin diamond drilling in the spring of 1938. The *Krebbs Pigment Division* of the DuPont Co. is conducting the work. Geo. H. Anderson, Ph.D., of the California Institute of Technology, is in charge of the work. Jack George is foreman on the ground and C. A. Dawson is in charge of the magnetometer work.

Eighteen men are employed.

FERTILIZER

Sheba Fertilizer Deposit, comprising 160 acres of patented land, is situated at the west end of Soledad Canyon, just north of the Mint Canyon highway. Owner, Eugene Graves, 4358 Elizabeth St., Bell, California. Wm. Smith, of Palmdale, California, is associated with Mr. Graves in this enterprise.

A dike in the granitic country rock which, on the surface, appears to be about 100 ft. wide, has been traced by trenching some 1500 ft. along its northwest strike. The dike rock, which is considerably altered by decomposition, is reported to be valuable as fertilizer.

Development consists of a tunnel driven northwesterly about 100 ft. A trestle and bins have been built and it is intended to erect at once, a 100-ton grinding plant.

Two men are working on construction.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

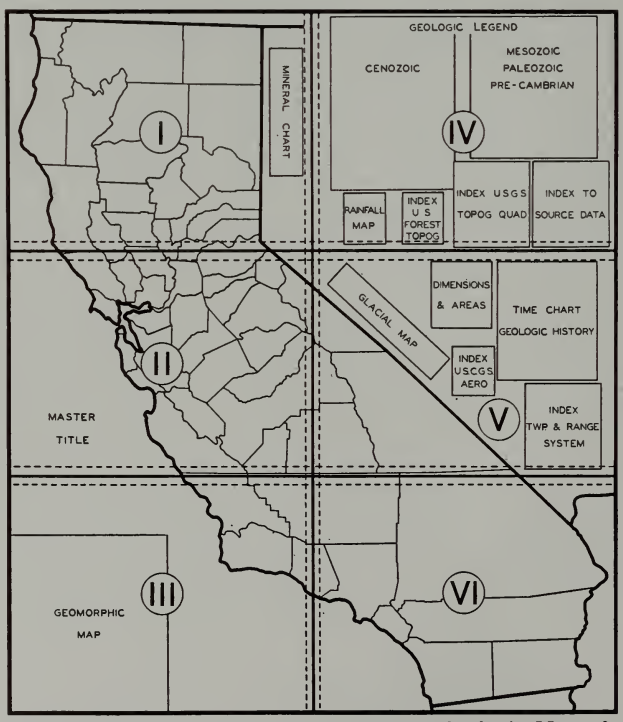
In this issue of the Journal, Dr. Gordon B. Oakeshott has contributed a paper on the "Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County." The report is virtually a detailed geologic cross-section of an interesting mountainous region north of Los Angeles.

The new state geologic map is soon to go to the lithographer to be published, showing by colors and patterns the distribution of 80 different rock formations and periods. Though it is not entirely complete as to detail of mapping, practically 80 per cent is ready, and the constant demand from the public for the colored map has made it imperative that it be so published.

Two new bulletins, one on "Minerals of California" by Dr. Adolf Pabst, and the other, "Bibliography of the Geology and Mineral Deposits of California for the years 1931 to 1936 inclusive" by Dr. Solon Shedd, are now ready for the press.

Also on hand is a manuscript by Dr. John C. Hazzard on "Paleozoic Section in the Nopah-Resting Springs Mountains, Inyo County." This paper will be published in an early issue of the Journal together with an accompanying economic report on the same region by R. J. Sampson, assistant district mining engineer of the Division of Mines.

Correction: In April issue, on page 146, third line from last, "Spondumene" should read *Spodumene.*



Index to arrangement of the Six Sheets of the New Geologic Map of California, now in press.

GEOLOGY AND MINERAL DEPOSITS OF THE WESTERN SAN GABRIEL MOUNTAINS, LOS ANGELES COUNTY*

By Gordon B. Oakeshott**

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* Synopsis of a Ph.D. thesis submitted to the University of Southern California.
** Professor of Geology, Compton Junior College, Los Angeles County.

INTRODUCTION

ABSTRACT

The oldest formation in the western San Gabriel region is the Placerita series, consisting of scattered fragments of once extensive marine limestone, dolomite, shale, and sandstone; now crystalline limestone, schists, and quartzites. Although no fossils were found, certain comparisons (mode of occurrence, distribution, and composition) with the Furnace (Mississippian?) limestone of the San Bernardino Mountains lead to the conclusion that its most probable age is Carboniferous (?). The oldest intrusive rock is the Rubio diorite and diorite-gneiss, whose age is pre-Upper Jurassic (?) and post-Carboniferous (?); probably late Paleozoic. By far the most widely distributed rocks are a complex series of closely related plutonics exposed in the central and northern parts of the range. The principal groups of rocks represented are gabbro-diorite, anorthosite, syenite-monzonite, and granodiorite-granite. Their field relationships, distribution, primary structural features and petrology indicate that they are of co-magmatic origin and have been derived by differentiation from an original dioritic (or quartz diorite) magma. The facies did not consolidate simultaneously but overlapped in the general order of the series just named. They are a part of the great San Gabriel batholithic intrusion generally considered as Upper Jurassic (?).

The oldest Tertiary formation in the region, previously mapped as Miocene and as Cretaceous (?) or Eocene (?) is proved to be Martinez (lower Eocene). A thin sliver of the formation, heretofore unmapped, has been recognized in Pacoima Canyon. The Mint Canyon formation was found to lie on gabbro with a depositional contact in the vicinity of Oak Spring Canyon where it had previously been mapped as faulted. North and south of this locality the fault contact was found to be complicated by branching faults. On the south side of the range previously mapped "Miocene" formations are found to be Modelo. Unconformities are recognized between Pico and Modelo, and Saugus and Pico, although there is only local angular discordance. South-side faults, with the exception of a few of small displacement, were found to be reverse faults. They are explained here on the basis of folding accompanying faulting. Previously published conclusions concerning the north-side Soledad fault had be to modified. The Pole Canyon reverse fault, not recognized by earlier writers, was mapped, and an explanation is suggested for its association with the normal Soledad fault.

The geology was plotted in the field, with as much detail as possible, on aerial photographs on an approximate scale of one inch to 1,500 feet (1:18,000) and transferred to topographic maps, scale one inch to 2,000 feet (1:24,000). The geology as completed covers portions of three six-minute U. S. Geological Survey topographic quadrangles—Lang, Little Tujunga, and Sunland—and furnishes a detailed section across the western San Gabriel Range.

Mineral deposits which have been mined in the past include dolomitic limestone, graphite, and titaniferous iron ore. At present the limestone is being quarried from Limerock Canyon. Placer gold has been found in small quantities, and chromite is present in basic gabbro. Three unsuccessful wells have been drilled for oil; oil has been produced for many years in Placerita Canyon, two miles west of the area mapped.

Geographic Description

The San Gabriel Mountain Range is one of the prominent east-west ranges of southern California, comprising an area of over a thousand square miles, with a length about twice its greatest width. It is bordered on the north by Soledad Canyon and by Victor Valley of the Mojave Desert, the valley of the Santa Clara River separating the range from the Sierra Pelona on the northwest. On the west, the San Gabriel Mountains continue into the Santa Susana Mountains

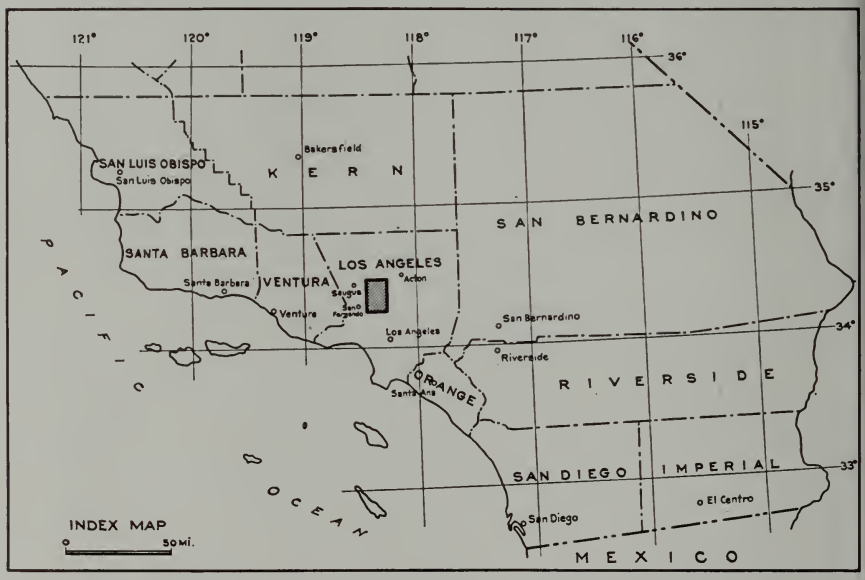

Fig. 1. Index map, showing the portion of the Western San Gabriel Mountains, described in this report: Little Tujunga quadrangle and adjacent portions of the Lang and Sunland quadrangles.

with no real break. Eastward, Cajon Pass marks a constriction which separates the San Gabriel and San Bernardino ranges. To the south lie San Fernando Valley and a series of foothills and valleys extending eastward. The range as a whole may be said to be in the early mature stage of the erosion cycle. It is thoroughly dissected into steep narrow canyons and ridges with elevations ranging from the lower valleys at about 1,200 feet up to peaks over 10,000 feet. The western end of the range is considerably lower than the maximum but retains its rugged character. The highest peak in the Little Tujunga quadrangle is Iron Mountain. It has an elevation of 4,878 feet. The area covered in this paper extends from the San Fernando Valley on the south due north across Soledad Canyon, and includes almost the com-

plete Little Tujunga quadrangle, the northern quarter of the Sunland quadrangle, and the southern third of the Lang quadrangle.

Acknowledgments

Acknowledgment is due Dr. Thomas Clements for his advice on many phases of the problem, and Dr. A. J. Tieje for checking the megafossil determinations. The writer is also indebted to Mr. Merle Slykhous, instructor in chemistry at Compton Junior College, for the series of limestone analyses, and to Mr. H. David Hobson of the Continental Oil Co., for discussions in the field. Excellent photographs by Fairchild Aerial Surveys made detailed mapping possible before the 1:24,000 topographic sheets were completed by the Los Angeles county surveyor.

TABULAR SUMMARY OF FORMATIONS

I. Cenozoic: Quaternary
- A. Recent
  - 1. Alluvium. Stream gravels and alluvial fan deposits.
- B. Pleistocene
  - 1. Terrace ---------- 0-75 feet
    Unconsolidated, poorly sorted slightly weathered stream deposits lying with almost their initial dips. In upper Lopez-Kagel Canyon region are terraces of two distinct ages; elsewhere correlation is uncertain. They lie with angular unconformity on Saugus.
  - 2. Saugus ---------- 0-5900 feet
    Thins rapidly toward east and north. Continental deposits, consisting of rather poorly consolidated, poorly sorted gravels and coarse sandstone. Red beds common in upper Saugus. Saugus lies on the Pico with a distinct disconformity, and probably angular discordance in the east.

II. Cenozoic: Tertiary
- A. Lower Pliocene
  - 1. Pico ---------- 350-1600 feet
    Marine deposits consisting of thick beds of conglomerate, sandstone, and brown shaly sandstone. Thins toward the east. Lies unconformably on Modelo but with only local angular discordance.
- B. Upper Miocene
  - 1. Modelo ---------- 2,000+ feet
    Base not exposed. Marine; arkose sandstone, beds of conglomerate, thin-bedded brown sandstone, calcareous and silicious shale, thin beds buff limestone, chert, and a little diatomite.
  - 2. Mint Canyon ---------- 3,900+ feet
    Top not mapped. Continental; massive, poorly sorted fanglomerate at base in some places, conglomerate, gravels, coarse sandstone. Alluvial fan, stream-laid and lake deposits make up most of the formation. Much of the Mint Canyon closely resembles Saugus. Contains vertebrate fossils. Lies in fault contact or unconformably on crystalline rocks in this area.
- C. Middle Miocene
  - 1. Basalt ---------- 0-300 feet
    Subaerial flow (?) lying on Upper Jurassic (?) granodiorite and apparently unconformably below Modelo.
- D. Lower Eocene
  - 1. Martinez
    Thickness not determinable because of fault contacts, but certainly more than a few hundred feet. Marine conglomerate, dark grayish and greenish sandstone, and dark shale, much brecciated.

III. Mesozoic
- A. Upper Jurassic (?)
  - 1. Granodiorite. Average composition varies from quartz diorite to granite. Intrudes Placerita and Rubio diorite but is essentially contemporaneous with and genetically related to syenite-monzonite, anorthosite, and gabbro-diorite.
  - 2. Syenite-monzonite. Intrusives varying in composition from alaskite through syenite to diorite, but very low in femic minerals.
  - 3. Anorthosite. Essentially andesine. Grades into syenite on the one hand and gabbro-diorite on the other.
  - 4. Gabbro-diorite. Includes a variety of intermediate to basic rocks; diorite, gabbro, diabase, pyroxenite, and iron ores. Appears to have been intruded slightly earlier than the associated intrusives.

IV. Paleozoic
- A. Late Paleozoic (?)
  - 1. Rubio Diorite. Diorite and hornblendite, the former usually gneissic. Intrudes Placerita and is intruded by granodiorite.
- B. Carboniferous (?)
  - 1. Placerita. Crystalline limestone; graphite, biotite, sillimanite, and tremolite schists; quartzite and schistose conglomerate. Remnants of an once extensive series of sedimentary rocks.

PRE-TERTIARY FORMATIONS

Placerita Meta-Sedimentary Series

General description

The Placerita series consists of a group of metamorphosed sedimentary rocks first described by Miller in 1930[1] and later[2] more completely treated by the same author. The type locality was taken in Placerita Canyon just west of the Little Tujunga quadrangle and south of the Dillon-De Mille fault zone, where the formation has been most completely preserved. In the Little Tujunga region, principally west of Little Tujunga Canyon between the Lopez and De Mille faults, Placerita meta-sediments are found in small patches included in Rubio diorite and granodiorite. In the higher parts of the range north of the Dillon fault no remnants of the series have been found. Limestone, shale, carbonaceous shale, sandstone, and conglomerate have been very completely altered to crystalline limestone, graphite, biotite and sillimanite schists, quartzite, and gneiss.

Crystalline limestone and dolomite are interbedded with metamorphosed thin-bedded brown sandstone, pebbly sandstone and shale (all now principally quartzites), and mica, graphite, and sillimanite schists. The bedding planes are quite commonly distinguishable. Stratification and foliation planes are roughly parallel, so that the attitudes shown on the geologic map indicate general foliation and bedding. As a rule, dips are nearly vertical, with the general strike northwesterly. The remnants of the series are most commonly elongated in the same general direction. Strikes parallel the banding of the Rubio diorite, which has intricately intruded the Placerita. The association of Rubio diorite with outcrops of the meta-sediments is exceedingly common. The widely distributed small roof pendants and fragmented inclusions in Rubio diorite and in the granodiorite indicate the Placerita was probably originally a thick and widespread formation. The deeper erosion north of the Dillon fault has removed all traces of the old sedimentary series; no xenoliths were found north of the fault. No estimate of the thickness of the Placerita is possible from the scattered fragmentary occurrences in the Little Tujunga quadrangle. Miller,[3] however, suggests at least 5,000 feet, from observations in the Placerita Canyon district.

Crystalline Limestone and Dolomite

The most prominent rock consists of white crystalline limestone and dolomite, small remnants of which are widely distributed. Megascopically it is usually a medium- to coarse-grained white marble. Crystals of calcite up to a half inch in length are common. Fine-grained limestone is found, but all of it has been recrystallized. Not all of it is pure calcite but much of it indicates by color and composition derivation from calcareous argillaceous and arenaceous sediments. One of the commonest accessory minerals is graphite which occurs in

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[1] Miller, W. J., Rocks of the southwestern San Gabriel mountains of California: Bull. Geol. Soc. Am., vol. 41, p. 149, 1930.

[2] Miller, W. J., Geology of the western San Gabriel mountains of California: Univ. Calif. at L.A. Pub. in Math. and Phys. Sci., vol. 1, no. 1, 114 pp., 1934.

[3] Miller, W. J., *op. cit.*, p. 7.

small flakes in the limestone in varying percentages. Near the contacts with intruding diorite and granodiorite, contact-metamorphic minerals are often developed. Particularly common are tremolite, brown and red garnet, epidote, and diopside. Less common are chlorite and a pale-brown mica (phlogopite ?). A typical specimen examined microscopically proved to be crystalline limestone containing calcite 86%, diopside 6%, cordierite 5%, graphite 2%, brownish iron oxides 1%, and a few small grains of titanite. A small percentage of the "calcite" is strongly zoned and probably is dolomite. However, typical dolomite rhombs are not present. The mineral composition indicates derivation from a dolomitic limestone carrying a small percentage of clay. Much of the Placerita crystalline limestone is more nearly pure carbonate.

Five typical analyses were made by Mr. Merle Slykhous, instructor in quantitative analysis at Compton Junior College; two were by Baverstock and Payne of Los Angeles[4]; the remaining three are of specimens from the Blackhawk Canyon[5] region in the San Bernardino Mountains, and are included for purposes of comparison. The "insoluble" is mainly graphite and silica.

Sample	*CaO*	*MgO*	*CO_2*	*Insoluble*
95-D	46.1	5.9	38.4	10.5
126A	38.7	20.3	40.5	0.7
96-7	54.1	0.4	42.0	2.8
126B	36.7	16.8	46.4	0.3
95-3	36.5	13.9	40.0	9.2
1	32.75	17.2	---	---
2	49.3	4.0	---	---
1358B[5]	55.3	0.5	---	---
1360A[5]	50.1	4.8	---	---
1363B[5]	31.2	19.7	---	---

Graphite, Sillimanite, and Biotite Schists

Graphite is a common mineral in the fine-grained schistose rocks of the Placerita, and in the limestone. It forms up to 20% of the "graphite schists," but in the hand specimen may seem, on cursory examination, to form a much larger part of the rock. Sillimanite, biotite, and albite, together or separately, and in various proportions, are common associate minerals. Under the microscope, one typical specimen was found to be principally sillimanite and biotite in about equal proportions, with a small percentage of graphite, quartz, cordierite, garnet, and titanite, named in order of abundance. The sillimanite is in long needles and narrow-bladed crystals. Blades of sillimanite are broken and partly replaced by cordierite and a matting of very fine fibrous minerals and small irregular grains including quartz, fibrous chalcedony, colorless garnet, sericite (?), and epidote. Biotite, graphite, and quartz occur in irregular grains molded against sillimanite. The biotite is a deep reddish brown in basal flakes. A common variant of this sillimanite-biotite schist is sillimanite-graphite schist, a rock in which the sillimanite blades are a little more prominent and graphite takes the place of most of the biotite. In some of the schists biotite is the predominant mineral. Another fine-granular and schistose rock containing abundant graphite was found microscopically

[4] Report of the State Mineralogist XIX, p. 165.
[5] Woodford, A. O., and Harriss, T. F., Geology of Blackhawk Canyon, San Bernardino mountains, California: Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 17, pp. 265-304, 1928.

to be a graphite-albite schist. Albite makes up 80% of the rock, graphite 12%, reddish-brown slightly-pleochroic rutile 1%, small flakes of muscovite 1%, and alteration products the balance. The alteration products are in irregular fractures, in cleavage cracks, and between grains of feldspar. This thoroughly altered feldspar is probably a more basic plagioclase than albite. Recognizable minerals include granular greenish-yellow epidote, chlorite, fibrous chalcedony, and isotropic pale brownish opal (?).

The origin and occurrence of the graphite is considered below in the section on mineral deposits.

Meta-arenaceous Rocks

Coarse-grained clastic sediments make up only a small part of the Placerita series, but they do occur in thin beds just west of Little Tujunga Canyon. The degree of metamorphism varies greatly, but bedding has rarely been completely obliterated. Thin beds of conglomerate gneiss occur in quartzite east of Herrick Canyon. The conglomerate consists of small angular and sub-rounded pebbles of quartz up to a half-inch in diameter in a matrix of coarse- to fine-grained quartzite. A thin-section typical of the Placerita quartzite was found to consist of quartz 73%, oligoclase and albite 25%, muscovite 1%, and zircon, rutile, and magnetite 1%. A few quartz grains appear to have been rounded and enlarged by secondary deposition of quartz. The rock clearly has been derived from a feldspathic sandstone.

Origin and Age of the Placerita

Although no fossils have been found in the formation, the considerable thicknesses of pure limestone and general considerations of lithology indicate it was largely, if not wholly, of marine origin. The widely distributed patches throughout the western San Gabriel Mountains show that the present outcrops are but fragments of a once widely distributed formation left after deep and long erosion. It is quite probable that some of the metamorphosed sediments of the Pelona series [6] in the Sierra Pelona are to be correlated with the Placerita as well as crystalline limestone of the Blackhawk Canyon region and other occurrences in the San Bernardino Mountains. Woodford and Harriss [7] have made a careful study of the Furnace crystalline limestone (believed by Vaughan [8] to be Ordovician) and from fossils collected by them Girty has suggested Carboniferous (?) or possible Mississippian (?) age. The fossiliferous limestone is metamorphic, containing diopside (?) and tremolite; nevertheless the fossils have not been destroyed. The most patient search has failed to reveal any fossils in the Placerita crystalline limestone, but the success of Woodford and Harriss in a similar occurrence suggests they may yet be found.

Since the Placerita formation is so discontinuous and contains no fossils, its age is impossible to determine with certainty. Nothing like it

[6] Simpson, E. C., Geology and mineral deposits of the Elizabeth Lake quadrangle, California: Calif. Jour. Mines and Geol., vol. 30, No. 4, Oct., 1934, State Div. of Mines.

[7] Woodford, A. O. and Harriss, T. F., Geology of Blackhawk canyon, San Bernardino mountains, California: Univ. of Calif. Publ. Bull. Dept. Geol. Sci., vol. 17, pp. 265-304, 1928.

[8] Vaughan, F. E., Geology of the San Bernardino mountains north of San Gorgonio Pass: Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 13, pp. 319-411, 1922.

of Cenozoic or of Mesozoic age is known in southern California, so it is almost certainly Paleozoic or older. Miller[9] assigns the Placerita to pre-Cambrian time, apparently for three reasons: (1) He believes it to be more metamorphosed than any known Paleozoic rocks in California including the Mississippian (?) Furnace limestone, (2) known California Paleozoic rocks are "never notably injected *lit-par-lit* by granite" and (3) Placerita rocks are older than anorthosite, which he believes is pre-Cambrian.

The author has examined occurrences of limestone mapped as Furnace in the Blackhawk Canyon region, which are identical with many of the outcrops of crystalline Placerita limestone in the Little Tujunga quadrangle. The latter are by no means always *lit-par-lit* injected. Woodford and Harriss[10] refer to the Furnace limestone as "crystalline" with much tremolite, and "also occasionally present chlorite, quartz, garnet, diopside, graphite," etc. Both their description and analyses would apply to much of the Placerita limestone as well as the Furnace. The Furnace limestone was certainly a widespread formation at one time, quite probably extending at least as far westward and northward as the western San Gabriel Mountains. *Therefore because of similar field relations, petrology and petrography, and chemical analyses, and because both Furnace and Placerita were evidently of more than local extent, they are here tentatively correlated, and the suggestion is made that the most likely age of the Placerita is Carboniferous.* If the Furnace limestone is somewhat less intensely metamorphosed than the Placerita it may be explained by the fact that only tiny fragments of the latter remain included in diorite and granodiorite, while quite large areas of the Furnace remain.

Rubio Diorite

The Rubio diorite is exposed principally between Little Tujunga and Pacoima canyons and just north of the belt of Tertiary sediments which fronts the range. The formation name was proposed by Miller[11] from the type locality in Rubio Canyon a few miles east of the Little Tujunga quadrangle. The largest exposures are found east of Pacoima Dam and just north of the De Mille fault. Elsewhere it occurs in small patches in granodiorite, often closely associated with remnants of the Placerita meta-sediments which it has intruded.

For the most part it is a rather dark, medium-grained gneiss containing a good deal of hornblende, little quartz, and with the composition of a diorite. Segregations of hornblende on both a small and large scale are of frequent occurrence. The gneissic banding is often very uniform, maintaining the same attitude for hundreds of feet in a given outcrop. Dips are usually nearly vertical and strike predominantly northwest. The banding varies in thickness from a fraction of an inch to about a foot. Such banding is evidently due to regional metamorphism as a result of orogenic processes. This conclusion is substantiated by the common development of biotite schists evidently derived from the diorite, and the occurrence in places of crystalloblastic textures. Some of the banding of Rubio diorite gneiss is, however, a primary flow structure. In the complex association of

[9] Miller, W. J., *op. cit.*, pp. 64-65.
[10] Woodford, A. O., and Harriss, T. F., *op. cit.*, pp. 268-71.
[11] *Op. cit.*, p. 7.

crystalline rocks between Little Tujunga and Buck canyons, banding of the Rubio diorite gneiss is particularly prominent. Some of it has been injected *lit-par-lit* for hundreds of feet by granodiorite. Granodiorite directly cuts across Rubio gneiss just west of the Lopez fault in upper Little Tujunga. The intrusive relationship of the granodiorite to Rubio diorite is particularly clear at that locality.

Just north of the Dillon fault is a thoroughly metamorphosed series of intrusions which is tentatively correlated with Rubio diorite. Much of it is so completely shattered, metamorphosed, and altered as to obscure the original character of the rock. It is irregularly intruded by the granodiorite and carries inclusions of Placerita limestone.

The age of the Rubio diorite can not be conclusively determined but there are several considerations which suggest late Paleozoic. As mentioned above, Rubio has clearly been intruded by Upper Jurassic (?) granodiorite which in a number of places cuts across the secondary gneissic banding; notably just west of Little Tujunga Canyon and on the Little Tujunga road near its horseshoe bend in Buck Canyon. In the canyon northwest of the junction of Little Tujunga and Gold Creek roads the diorite has intruded and metamorphosed Placerita limestone. Thus there can be no doubt of the post-Placerita (Carboniferous?) and pre-granodiorite (Upper Jurassic?) age of the Rubio diorite. It is highly improbable that it is of Triassic or Lower Jurassic age since no plutonic intrusions of that age are known or suspected in California. However a number of workers have recognized the probability of mountain building and plutonic invasion of the Sierra Nevada in late Paleozoic time. Therefore, in the absence of more definite evidence, the Rubio diorite is assigned to the late Paleozoic, posisbly Permian or Pennsylvanian.

Upper Jurassic (?) Intrusives

Exposed in the central part of the western San Gabriel Mountains is a complex series of closely related intrusive rocks. There are some slight differences in age but evidence will be presented to show that they belong to the same great plutonic invasion, which probably occurred in Upper Jurassic time. A great variety of plutonic rocks is represented ranging from ultrabasic magnetite-ilmenite and pyroxenite to the acid alaskite and granite-pegmatite. The commonest types are gabbro, diorite, anorthosite, syenite, monzonite, granodiorite, and granite.

Gabbro-diorite

The plutonics mapped as the gabbro-diorite series are exposed continuously north of the Dillon fault to the Pole Canyon fault. The most acidic facies is found near the southern part of the Little Tujunga quadrangle where some of the rock is a true quartz diorite.

The central and northern parts of the gabbro-diorite are much more basic but the change is a gradational one. From Pacoima Canyon northward the composition becomes generally more basic, and the rocks may truly be called diorite and gabbro. The principal changes are a large increase in femic minerals, disappearance of quartz and orthoclase, and a slightly more calcic feldspar. A typical composition of the gabbro as revealed by the petrographic microscope is andesine-

labradorite 72%, augite 10%, olivine 7%, ilmenite-magnetite 8%, and apatite 3%. The feldspar often shows peculiar cataclastic structure—fine wavy striations—found also in the quartz diorite facies.

From Pacoima Creek west of Laurel Canyon a thin-section of a pyroxenite facies of the gabbro containing chromite was examined. (See section on *Chromite*, p. 243.) Other basic rocks of the gabbro-diorite series include magnetite, ilmenite, and rocks in which these minerals are associated with pyroxene and olivine. Typical coarse-grained diallage gabbro occurs on the main ridge 2,000 feet west of Dagger Canyon. Diabasic facies of the gabbro are not rare; examples are found near the mouth of Laurel Canyon, in Iron Canyon, and in Soledad Canyon south of the Pole Canyon fault across the creek from

FIG. 2. White syenite 'intrusions' in dark gabbro. Lower Pole Canyon.

Soledad Sulphur Springs. Further mention of ilmenite, magnetite, and chromite will be found in the section on mineral deposits.

On the Sand Creek trail west of Dagger Canyon a porphyritic facies of the diorite is encountered. Feldspar crystals up to two inches long are set in a coarse-grained matrix of quartz diorite. Lamprophyric dikes are occasionally found. Northward along this same trail as Iron Mountain is approached the feldspar masses become larger and more frequent until the diorite-gabbro grades into pure grayish-purple anorthosite. Due south of Iron Mountain anorthosite is much more sharply separated from the gabbro. Much of the gabbro is coarse-grained and almost black, with a high percentage of the femic minerals. Locally, pyroxenite and almost pure masses of the

iron ores are developed. Even in such basic material an occasional lense of quartz is found. Such an association appears to indicate a complete differentiation of what was probably a gabbroic magma. The gabbroic magma itself developed within the great magma chamber by differentiation, remained molten long enough to completely segregate salic and femic constituents developing the ultra-basic pyroxenite-iron ores and small amounts of complementary quartz.

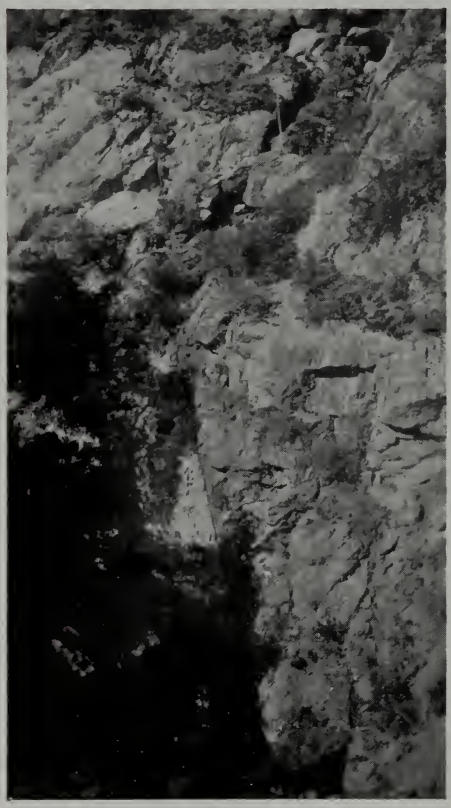

FIG. 3. Looking west along strike of Dillon fault, near west end. Biotite granodiorite on left, dark quartz diorite-monzonite on right.

Anorthosite

True anorthosite is of limited extent in the area mapped, outcropping over about three square miles in the Little Tujunga quadrangle. It possibly is more extensive to the east. The larger area centers around Iron Mountain and occurs on the south slopes of the mountain. Typically the rock is faintly grayish or purplish plagioclase varying from medium-grained to coarse-grained, some plagioclase crystals being as large as one inch in diameter. Minute flecks of muscovite may sometimes be noted, and altered pyroxenes are frequently present in very small percentages. Southwest of Iron Moun-

tain the anorthosite passes into gabbro and diorite by increase of the femic constituents. North of Iron Mountain it grades imperceptibly into pure white syenite and related rocks by increase of orthoclase and microcline at the expense of plagioclase. Microscopic examination of several anorthosite grains showed none more basic than acid labradorite while most were of the composition of andesine. In the field this rock can be distinguished from syenite and alaskite only by careful examination of each specimen, making mapping of contacts difficult.

Syenite and Monzonite

Syenite outcrops over several square miles north and northwest of Iron Mountain almost to Lang. It is a very striking rock in the field because of its dazzlingly white color. The rock has not previously been recognized as syenite.

The close resemblance of the syenite to anorthosite has been mentioned, but near Lang, where it is typically developed, it is whiter than anorthosite. It is unfoliated, but like the anorthosite minutely fractured and always altered to some extent. The rock grades into anorthosite on the one hand and granite and granodiorite on the other. Some of the rocks on the south side of the range just north of the Dillon fault are closely related to the syenites of the north side but were mapped in the field as monzonite because they contain a considerable percentage of altered pyroxene and a higher percentage of plagioclase.

Andesine in thin sections of syenite and monzonite is quite generally sausseritized, with epidote, chlorite, quartz, and calcite as recognizable grains. The potash feldspars are commonly sericitized but some show kaolinization. In several sections the alteration made calculation of the percentages of each feldspar uncertain. Microcline is almost as abundant as orthoclase, occurring in all but one of the thin sections examined. The average rock is 85% feldspar; plagioclase and orthoclase-microcline are often present in nearly equal proportions but the ratio varies considerably. Quartz is generally lacking as a primary mineral, but is present near the gradational contacts with granodiorite. Muscovite is a very persistent accessory and in the form of sericite is a very common secondary mineral from feldspar alteration. Almost colorless augite is a prominent accessory in some sections. Apatite in subhedral crystals up to one and a half millimeters long is an abundant accessory only near the gradational contacts with gabbro. Biotite was originally somewhat more abundant than appears, since much of the chlorite is the result of alteration of biotite. Notable in this suite of rocks is the low percentage of femic minerals and the entire lack of hornblende.

Granodiorite-granite

The largest area of the granodiorite-granite series occurs south of the Dillon fault and north of the Lopez and Sunland faults. The only other exposures are on the north side of the range south of Alpine and Russ in Soledad Canyon. Within these two regions there is considerable variation in rock type. The variants are obviously facies of the same intrusion and include rocks ranging from alkali granite to diorite; granodiorite, however, is the commonest and most widely dis-

tributed. The contacts between facies are usually gradational, but in some places are sharp. Quite a common facies is a true granite containing pink orthoclase; just south of Soledad Canyon it grades into syenite and also into granite-pegmatite. Coarse-grained biotite granite is also of common occurrence. The opposite extreme in composition is quartz diorite. A specimen of the latter from the vicinity of Pacoima Dam was found to contain 11% quartz, 62% andesine, 1% microcline, 16% biotite, 7% hornblende, 2% magnetite, and 1% apatite.

Probably the most widely distributed facies is granodiorite, usually a biotite granodiorite; however, some hornblende is present. There is usually uncertainty in the field in distinguishing between granite and granodiorite, but in general the granodiorite is darker and rarely carries the pink orthoclase feldspar which is so common in some of the granite. The texture varies from fine granitic to coarse granitic. Average composition of several typical specimens was found to be quartz 26%, orthoclase 20%, oligoclase 39%, microcline 5%, perthite 1%, biotite 8%, and magnetite and apatite less than 1%.

FIG. 4. Pink granite on right sending small dikes into dark Rubio diorite. Little Tujunga road near horseshoe bend in Buck Canyon.

Structure of the Plutonics

Field observations of foliation, joints, fractures, faults, dikes and veins, flow lines and orientation of inclusions were taken for their bearing on the origin and relations of the series of plutonic rocks of the Upper Jurassic (?). One difficulty in the general consideration of the evidence of structural features on origin and emplacement is that only the structures of the intrusives themselves can be considered. Only the granodiorite-granite group is anywhere in direct intrusive contact with the older rocks. The older formations (Placerita and Rubio) are so fragmentary as to leave little evidence as to how the intrusives penetrated them. The former occur simply as fragments caught up in the later intrusive magmas. Granodiorite and granite very definitely cut across the rather uniform gneissic banding of the Rubio diorite, and in some places have injected it *lit-par-lit*. Just

west of upper Little Tujunga Canyon this feature may be observed where pink granite has injected diorite-gneiss in thin stringers paralleling its schistosity; but the general granite-diorite-gneiss contact is almost at right angles to the foliation. Other similar observations may be made to the southwest, north of the major bend in the Lopez fault. The granite itself near such contacts is apparently unchanged, showing no chilled border or change in composition. For the most part the numerous xenoliths of diorite gneiss and Placerita meta-sediment that appear in the granodiorite are irregularly distributed and unoriented. However, examination of the geologic map will show that more are elongated in a northwesterly direction than any other. Dips of the Placerita planes of schistosity, and gneissic bands of the Rubio, are very largely vertical or nearly so.

Granodiorite, granite, syenite, and anorthosite are massive, showing little foliation of any kind. The syenite group and anorthosite, since they were made up almost wholly of white minerals, probably seem more free from foliation than they actually are. Foliated granodiorite was observed in some localities; the foliation is indefinite, discontinuous, and due apparently to a partial separation of dark and light minerals during slow magmatic movements.

The monzonite and diorite rocks along the south side of the range north of the Dillon fault are definitely foliated. Foliation is also characteristic of most of the gabbro but seems to be somewhat more common south of upper Sand Canyon than north of it. The dark coarse gabbro of the Lang quadrangle is in general the most massive of the gabbro-diorite series. While gneissic banding is rather general throughout this series it varies so much in attitude in any small area as to make the taking of dips and strikes in most cases impossible and meaningless. In conclusion, concerning foliation of the gabbro-diorite series, most of it is primary, a kind of flow structure which may be developed in a viscous magma before final consolidation. There is no general uniformity in attitude of the foliation but nearly vertical dips are commonest. This probably indicates a general near-vertical upward movement of the magma before solidification.

No regular patterns of joints, fractures, or faults were observed, although parts of the gabbro-diorite series especially were greatly sheared, fractured, and contorted. *The greater foliation, shearing, fracturing, and alteration of the gabbro-diorite series is explained by the fact that solidification of that magma began first, and as it progressed, continued intrusive movements of the more acidic magmas affected the partly solidified gabbro. Granodiorite and granite, the last to become solid rocks, show least foliation, shearing, jointing, and fracturing.*

Origin and emplacement of the intrusions

The question of origin and emplacement of the intrusions may be considered from several lines of field and laboratory investigation. They are principally: (1) field relationships of the plutonic rocks, (2) distribution of the various facies, (3) primary structural features, and (4) petrographic studies.

The only previous studies of the western San Gabriel gabbro-anorthosite and associated rocks are those made by Miller, summarized

in his last paper [12] on the region. His western San Gabriel investigations were made a few years after his studies of the Adirondack anorthosite.[13] The work of two other workers in the Adirondacks has influenced this paper: Bowen [14] and Balk.[15] The conclusions of these three workers in the Adirondacks are of interest because the associated rocks —anorthosite, gabbro, syenite and granite—are similar to the western San Gabriel rocks. Balk's conclusions are, briefly that: (1) A thick sill-like mass of poorly differentiated parental magma of composition "more silicious than that of a gabbro" advanced obliquely upward. (2) Gabbro and anorthosite are "crystal differentiates, produced by the mechanical accumulation of solid mineral grains," while "syenite plays the role of the mother liquor from which the two other rocks are differentiated." The principal factor in the differentiation is the "friction which the magma encounters as it moves along relatively stationary walls. Under such conditions, the suspended solid crystals with their greater surface friction are being retarded with reference to the liquid portion of the magma." (3) The gabbros were the first to consolidate, but continued to form until the magma chamber was chilled, and the anorthosite preceded the syenite in consolidation. Bowen explained the positions and relations of the igneous rocks of the Adirondacks by theories of crystal settling and fractional crystallization. Miller believes that (in the Adirondacks) the syenite-granite magma was batholithically intruded after consolidation of the anorthosite. He also assumes in general that the magmas rose vertically as dome-shaped masses.

Of course, the western San Gabriel occurrence presents a distinct and entirely separate problem from that of the Adirondack intrusives and the conclusions mentioned above concerning those intrusives are of importance only as they suggest lines of investigation and modes of attack of the western San Gabriel problem. Each of the four lines of investigation mentioned in the opening paragraph of this section on *origin and emplacement* will now be briefly considered, and its implications suggested.

(1) Field relationships of the plutonic rocks have been mentioned above in several places but the evidence may be summarized here. Gabbro-diorite appears to be older or contemporaneous with the syenite-monzonite and anorthosite. 2,000-3,000 feet southwest of Iron Mountain, diorite and coarse gabbro merge gradually into true anorthosite by the disappearance of the femic minerals. Near the contact, patches and zones of pure plagioclase become more and more frequent in the gabbro until the dark minerals completely disappear. In lower Iron Canyon segregations of pure grayish feldspar are common in the dark gabbro, ranging in size from an inch or so across to several feet in diameter. The difference between such "segregations" and the larger mapable masses of anorthosite seems to be only a matter of size. Elsewhere anorthosite may appear to intrude gabbro. For example, in

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[12] Miller, W. J., Geology of the western San Gabriel mountains of California: Univ. Calif. at L. A. Pub. in Math. and Phys. Sci., vol. 1, no. 1, pp. 1-114, 1934.

[13] Miller, W. J., Adirondack anorthosite: Geol. Soc. Am. Bull., vol. 29, pp. 399-462, 1918. Significance of newly found Adirondack anorthosite: Am. Jour. Sci vol. 18, pp. 383-400, 1929.

[14] Bowen, N. L. The problem of the anorthosites: Jour. Geol., vol. 25, pp. 209-243, 500-512, 1917.

[15] Balk, R., Structural geology of the Adirondack anorthosite: Mineral and petrog. Mitteil., Bd. 45, pp. 308-432, 1931.

lower Dagger Creek gneissic gabbro and diorite is intruded by thin dikes and lenses of anorthosite roughly paralleling the gneissic banding, or, in some places, cross-cutting it. Syenite-monzonite similarly appears to have intruded gabbro in some places, notably near the mouth of Bear Canyon and on the north side of lower Pole Canyon. Dozens of observations similar to the above suggest the conclusion that *solidification of the gabbro-diorite magma began first but that before its completion consolidation of anorthosite and syenite magmas began, continuing in some places after complete freezing of the gabbro-diorite.*

Relationship of the syenite group to anorthosite is most clearly seen in a rather inaccessible region, namely the north slopes of Iron Mountain. In that region the almost-white anorthosite grades imperceptibly into pure white syenite; no sharp or intrusive contact could be found. Thus syenite-monzonite seems to have solidified in that region at the same time as the anorthosite.

Relation of the granodiorite-granite to the syenite group appears to be that produced by almost simultaneous consolidation but with some evidence that solidification of the more acid granite and granite-pegmatite took place last. East of Soledad Sulphur Springs, and particularly near the tunnel on the new Soledad Canyon road, pinkish granite grades imperceptibly into white syenite. Again in Soledad Canyon, a few feet north of the Pole Canyon fault, almost white granite merges into pure white syenite with no possibility of an intrusive relationship. However, in lower Bear Canyon and across Soledad Canyon from Alpine, tongues of pink granite appear to have injected syenite; but even in the same region apparent intrusions of syenite into granite take place.

(2) Distribution of the various facies. Anorthosite occupies a north-central position in the region, and is exposed over about three square miles in the Little Tujunga quadrangle, centering around the highest elevation, Iron Mountain. Gabbro-diorite occupies an area several times as large lying to the south, west, and northwest of the anorthosite. The syenite occupies most prominently an area in the northeastern section of the map, and monzonite (in a variety containing some femic minerals and grading into quartz diorite) a zone north of the Dillon fault entirely across the map. Granodiorite-granite outcrops in a large area in the northeast, also entirely across the map south of the Dillon fault.

In any consideration of distributions the whole western San Gabriel Mountain region must be taken into account. If this is done, the predominant rock type is unquestionably granodiorite. The gabbro-diorite-anorthosite series is bordered on the south, north, and northeast by syenite-monzonite rocks, which in turn grade into granite and granodiorite. Further investigation to the east would probably reveal essentially the same gradation. The northwest border of the gabbro is overlain by the later Mint Canyon sediments, so the border characteristics of the gabbro there must remain unknown.

(3) The most prominent primary structural feature of the plutonic rocks is the almost universal foliation of the gabbro-diorite series and the monzonite and diorite along the south border near the Dillon fault. The banding is exceedingly irregular and discontinuous such as might be imagined to take place by convective movements in the

magma and flow before final consolidation. All attitudes of the foliation are to be found, but the dips are usually nearly vertical, a fact that would seem to indicate a general movement of the magma vertically upward before final consolidation, with many local deviations within the magma mass.

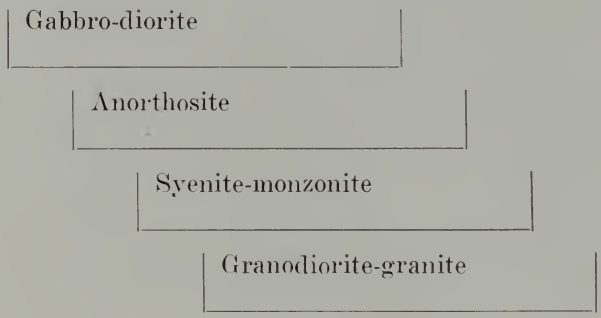
(4) Petrographic study emphasises the close relationship between rocks of the different facies and brings out some points concerning microscopic structures. The table compares rocks typical of the common facies. Numbers represent percentages; if no number follows a mineral name, it is present in less than one percent. Secondary minerals are in italics.

Examination of the table will suggest the close relationships between the rocks for which the composition is given. The feldspar andesine is the variety present in every case except in the granite and granodiorite. Andesine of the quartz diorite and olivine gabbro are identical in the thin sections, strengthening the field evidence that the two are facies of the same intrusion. Close relationship of the syenite and anorthosite is indicated by the presence of andesine as the soda-lime feldspar in each of the three sections; the only major difference in the three rocks is the relative proportions of soda-lime and potash feldspars.

In all the rocks the percentage of ferromagnesian minerals is low, the highest being the 25 per cent present in the olivine gabbro. The percentage of femic minerals in the syenite and quartz diorite is actually higher than appears since the chlorite represents the alteration of biotite or pyroxene. The granodiorite and granite resemble syenite in the presence of considerable percentages of both potash feldspars, orthoclase and microcline, and in a similar very low percentage of femic minerals. *In general, the seven rocks show such marked similarities as to constitute corroborative evidence of their co-magmatic origin.*

Locality	Rock name	Primary quartz	Potash feldspar	Sodalime feldspar	Characterizing accessories	Minor accessories and secondary minerals
Pacoima Dam	Biotite granodiorite	30	Orth. 22 Micro. 5	Oligoclase 35 (ab 75 and 25)	Biotite 8	Magnetite apatite *calcite*
Junction Little Tujunga and Buck Canyons	Biotite granite	37	Orth. 38 Micro. 6 Perthite 6	Oligoclase 10 (ab 75 and 25)	Biotite 2	magnetite 1
Soledad Canyon near Pole Canyon fault	Syenite (?)	0	Orth. 25 Micro. 15	Andesine 46 (ab 64 and 36)	Muscovite 2 Augite 1	*chlorite* 10 *epidote* 1 apatite *sericite*
Soledad Canyon, 3,000 feet east of Lang	Syenite	0	Orth. 20 Micro. 38	Andesine 30 (ab 65 and 35)	Muscovite 5	*quartz* *sericite* *kaolin* *epidote* 7
Iron Mountain	Anorthosite	0	Micro.—a few grains	Andesine 95 (ab 58 and 42)	Muscovite 4	*sericite*, magnetite *epidote* *clinozoisite* (?) *iron oxide*
West end of Dillon fault, north side	Quartz diorite	15 (?)	Micro. 5	Andesine (?) 57 (cataclastic striations characteristic)	Biotite 1	*quartz* 15 (?) *chlorite* 7 magnetite apatite
Iron Canyon, 4,000 feet from mouth	Olivine gabbro	0	0	Andesine (?) 72 (cataclastic striations characteristic)	Olivine 7 Augite 10	magnetite 4 *magnetite* 4 apatite 3

Conclusions—The evidence outlined above appears to support the following conclusions: (1) The original composition of the magma of the western San Gabriel Upper Jurassic (?) intrusives was about that of a diorite, possibly a quartz diorite. The proportion of basic rocks (gabbro group) is small compared to the total of anorthosite, syenite, granodiorite, and granite. This proportion, of course, is not quantitatively known, but a general estimate can be made from known exposures in the western San Gabriel Mountains. (2) The rocks are co-magmatic differentiates. (3) They did not consolidate simultaneously but solidification of the various groups overlapped; gabbro-diorite first, granite last. The general relationship of the four major rock types can be indicated diagrammatically in this way, each line representing time during which solid rock of the composition indicated was being formed:



(4) The magma currents moved nearly vertically upward, but all sorts of minor currents developed, and were reflected in the irregular gneissic banding. (5) The rocks are part of the great San Gabriel batholith. (6) Concerning the mode of differentiation the evidence presented appears to favor Bowen's[16] theories in a general way. That is, the original magma differentiated unevenly but largely under gravitational influences, with the femic constituents settling and the residual more acidic magmas finally congealing as syenite-granite-granodiorite around the borders and partly above the gabbro and anorthosite.

TERTIARY AND QUATERNARY FORMATIONS

Martinez

The Martinez formation (lower Eocene) occurs in the western San Gabriel Mountains in slivers along the Watt and De Mille faults. It consists of dominantly coarse sediments, principally dark greenish-black sandstone and thin beds of dark shale interbedded with thick, massive, coarse, well-cemented conglomerate. The pebbles on the whole are well rounded. It is quite probable that the formation originally spread entirely across the range and connected with Martinez sediments at Rock Creek on the north margin of the San Gabriel Mountains.

[16] Bowen, N. L., The problem of the anorthosite: Jour. Geol., vol. 25, pp. 209-343, 500-512, 1917. Crystallization differentiation in igneous magmas: Jour. Geol., vol. 27, pp. 393-430, 1919.

Basalt

Vesicular basaltic volcanic rock lies on granodiorite near the northeast end of the Merrick syncline, and is unconformably overlain by upper Modelo sandstone. On the basis of lithology and stratigraphic position it is correlated with Topanga basalt (middle Miocene) in the eastern part of the Santa Monica Mountains.

Mint Canyon

The Mint Canyon formation is found north and northwest of the Soledad and Pole Canyon faults, and lying unconformably on gabbro in the vicinity of Oak Spring Canyon. It is wholly of continental origin, including coarse fanglomerate, sandstone, conglomerate, and some thin lacustrine clay and limestone beds. Pebbles show the lower part of the formation was derived wholly from a steep mountainous front immediately to the south.

Modelo

The Modelo formation outcrops in a continuous belt across the southern foothills of the San Gabriel Mountains. It consists of shallow-water marine deposits, and varies rapidly in lithology. Arkose sandstone, conglomerate, fine brownish sandstone, silicious buff-colored finely laminated shale, and thin beds of diatomite are the common rock types. The formation is coarsest in the west near Lopez Canyon, but east of Little Tujunga appears to thin as well as become finer grained. The top member of the Modelo near Lopez is a 250-foot conglomerate which completely lenses out just east of little Tujunga Canyon. Modelo seas probably extended little farther north than the present sediments.

Pico

Marine lower Pliocene beds overlie the Modelo disconformably west of Little Tujunga Canyon and with demonstrable angular unconformity east of that Canyon. The formation is mainly conglomerate and coarse to fine sandstone. The Pico thins rapidly toward the east and becomes wholly coarse conglomerate; it is overlapped to the east and north by the Saugus formation. Petrology indicates local derivation from the north and northeast, probably from a San Gabriel *massif* sharply uplifted at the close of the Miocene.

Saugus

The Saugus formation of the Little Tujunga region is wholly continental, and unconformably overlies Pico, Modelo, and the older crystalline rocks. Its lithology is highly variable, but it is dominantly coarse sandstone and gravel. Pebbles are entirely of formations now outcropping in the San Gabriel Mountains, and vary with the rock on which the formation lies. The Saugus formation overlaps all older formations to the north and progressively overlaps the Pico to the east on the south limb of the Merrick syncline.

Terrace Deposits

Terrace gravels occur in small patches overlying with near-flat dips all older formations. The materials are brownish and grayish,

dirty unsorted detritus entirely of local origin, sometimes including fragments several feet in diameter. The deposits are post-Saugus and later than all known faults and folds.

TERTIARY AND QUATERNARY STRUCTURE

Faulting

Several previous workers have referred to structural features of the western San Gabriel Mountains, but Hill's [17] structural analysis of the south side represents the only detailed work of its kind in the region. His conclusions indicate the area is "characterized by reverse faulting and absence of normal faulting." Miller,[18] however, believes that "high-angle thrust faulting occurred only where the lateral pressure was severe enough to deform old normal faults, and that, even so, these old faults in places may still retain their normal-fault characteristics." This problem will be discussed after the brief descriptions of each fault which follow. The fault names used for all faults on the south side of the range are those given by Hill. All faults were re-mapped and studied in detail by the author with the advantage of numerous new road cuts made since Hill's investigations.

The Principal Faults

Lopez Fault

The Lopez fault crosses upper Kagel and Lopez canyons striking in general N. 70° W. It continues eastward to within 1,600 feet of Little Tujunga Canyon where its strike changes abruptly to N. 35° E. Where the strike is westerly the fault trace indicates a very steep north dip measuring about 75° but at the type locality in Lopez Canyon it is as low as 50°. The Lopez fault, which itself is clearly a high-angle reverse fault, is locally complicated by small branching faults, at least one of which is normal, though most are reverse.

Displacement along the fault dies out to the northeast and in the vicinity of Pacoima Canyon at the west end. Maximum vertical displacement may be estimated near the major bend of the fault, using the base of the Saugus as it lies on granodiorite as the reference plane. This contact appears at an elevation of about 1,500 feet east of the fault and at 2,300 northwest of it. A maximum vertical displacement of 800+ feet is thus suggested.

Sunland Fault

The strike of the Sunland fault varies from N. 65° W. near the eastern border of the map to N. 25° W. as it approaches Little Tujunga Creek. The fault plane is not actually exposed anywhere in the region studied, but since it separates such widely different formations as Saugus gravels and granodiorite it can be closely traced. The contact in the field suggests a high-angle reverse fault; Saugus beds and Modelo beds overturned at steep angles near the fault help confirm this conclusion. Widening of the Little Tujunga road, where the contact crosses the road, perfectly exposes Saugus beds dipping unconformably to the southwest off Rubio diorite-gneiss at an angle of about 25°.

[17] Hill, M. L., *op. cit.*

[18] Miller, W. J. Geology of the western San Gabriel mountains of California: Univ. Calif. at L. A. Pub. in Math. and Phys. Sci., vol. 1, pp. 76-82, 1934.

Three hundred feet east of that point a similar contact is found and 1,800 feet farther east another exposure shows Saugus beds lying unconformably on the granodiorite and dipping 40° toward the southwest. *Thus direct evidence of the most convincing kind shows that the Sunland fault dies out about 2,000 feet southeast of Little Tujunga Canyon.*

Calculation of maximum displacement along the Sunland fault is full of uncertainties, but the most logical sections that can be drawn suggest it may be as much as 2,000 feet; horizontal displacement is small.

Buck Canyon Fault

Marking the extreme northwest limit of the Saugus formation is the Buck Canyon fault striking N. 75° E. to N. 85° E. It can be traced into granodiorite to the southwest, but appears to gradually die out. Traced to the east it acquires a more easterly strike and probably continues as the Watt fault. The fault plane dips northward wherever exposed, but the dip is variable; in general it steepens toward the west. With granodiorite on the north there can be no question of its reverse character. Displacement is mainly vertical, but there is no means of determining exactly how much. No Saugus appears north of the fault at the same elevation, and the base of the Saugus south of the fault would strike the fault plane about 900 feet below the surface, so the throw must be at least 900 feet.

Watt Fault

The Watt fault is a reverse fault, probably continuous with the Buck Canyon fault but the continuity is obscured by terrace deposits. It strikes roughly N. 70° W. and dips about 45° N. throughout most of its length, but locally dips are lower. Saugus strata steepen rapidly approaching the fault contact, until at the contact their dip and strike are almost the same as the dip and strike of the fault plane. Martinez beds on the upthrown side (north) are contorted and fractured. Throw is at least 2,000 feet as inferred from the fact that the base of the Saugus along Gold Creek if projected northward would intersect the Watt fault plane at least 2,000 feet below the surface; the Saugus does not appear north of the fault.

De Mille Fault

Closely associated with the Watt fault is the De Mille fault just north of it. The De Mille fault strikes about N. 70° W. entirely across the Little Tujunga quadrangle. It is also a reverse fault, but dips northward at a very high angle. The best exposures of the fault plane showed a measured dip of 83° N. Martinez beds on the south with Rubio diorite on the north indicate its reverse character. Displacement is impossible to determine but there has probably been a few hundred feet vertical displacement and possibly some horizontal displacement.

Dillon Fault

The Dillon fault is, like the De Mille, a steep north-dipping fault; but it displaces only crystalline rocks in the Little Tujunga quadrangle.

Average dip is 75° to 80° north. Just east of the Little Tujunga quadrangle, Martinez sediments on the south with granodiorite on the north show that it is a reverse fault.

Soledad Fault

The Soledad fault parallels the general trend of Soledad Canyon following along the north side and separating the Mint Canyon formation on the north from white syenite on the south. The present study indicates that the Soledad fault turns almost due south near its west end, for about 4,000 feet, where it is apparently cut off by the Pole Canyon fault without continuing farther to the southwest. Just before it reaches the Pole Canyon fault it dips about 55° W. The Soledad fault is a normal fault wherever exposed in the Lang quadrangle.

Pole Canyon Fault

The type locality of the Pole Canyon fault is taken on the east side of Pole Canyon 3,700 feet southeast of Lang station. At that

FIG. 5. Pole Canyon fault from Soledad Canyon. Dark gabbro on left, syenite on right.

point it is a well-defined single fault plane exposed for over 200 feet in dark coarse-grained gabbro; dip is 70° SE. and strike N. 55° E.

To the southwest the fault can be traced for 5,400 feet; then it completely dies out in Mint Canyon sediments. South of Pole Canyon, the Mint Canyon beds lie in fault contact with gabbro. The fault maintains its southeasterly dip directed toward the gabbro mass clearly indicating the Pole Canyon is a *reverse fault*. Where the Soledad and Pole Canyon faults come together a third perfectly exposed fault occurs dipping 50° southeast and exposing a sliver of Mint Canyon strata; it is certainly a normal fault.

FIG. 6. Type locality of Iron Mountain fault. White syenite on left, gabbro on right.

For over 3,000 feet north, and 4,000 feet south of Oak Spring Canyon, the Mint Canyon formation lies unconformably on dark coarse-grained gabbro. South of Oak Spring Canyon 4,400 feet, the Mint Canyon-gabbro contact is again a fault contact. Two fault planes are mapped with a sliver of Mint Canyon lying between them against dark gabbro. One fault, perfectly exposed, was marked by eight inches of gouge, and had a strike of N. 10° E. and vertical dip. Thus it is a normal fault. This fault zone dies out to the north but continues southward, possibly to the westward prolongation of the Dillon-De Mille (San Gabriel) fault zone.

Iron Mountain Fault

The type locality of the Iron Mountain fault is taken 6,200 feet N. 71° W. from Iron Mountain in a narrow canyon at elevation 3,600. Pure white syenite on the north is in contact with coarse dark gabbro on the south. Strike is N. 60° E. and dip 75° N. There is about one foot of brecciation and gouge. The fault may continue both eastward and westward for several thousand feet, but exposures of it could not be found. It is quite possible that the very steep north slope of Iron Mountain ridge is an eroded fault scarp. The north block would appear to be the downthrown side, making the Iron Mountain fault a normal one. It quite probably is of Quaternary age but such a suggestion cannot be proven.

Age of the Faulting

The time of latest significant movements along some of the faults can be fixed but the date of first movements along the same faults is much less certain.

On the south side of the range the Lopez, Buck Canyon, Watt, and De Mille faults have all affected Saugus beds but almost flat terrace deposits lie across the faults without displacement. *The principal time of movement, then, must have been post-Saugus and pre-terrace, that is, approximately middle Pleistocene.* As may be seen from the mapping, not all faults were exactly contemporaneous; but the differences in age are believed to be very small. As to the time of first movements, there seems to be little evidence that they originated before the Quaternary, although they may have done so. It is true the present San Gabriel Mountains were initially uplifted in upper Eocene or Oligocene time and again at various times in the Tertiary and Quaternary, but there is no direct evidence that any of the south-side faults mapped suffered movements before the middle Pleistocene. It is quite possible that earlier movements on the south side were largely by tilting and broad anticlinal uplift unaccompanied by major faulting.

On the north side faulting cannot be as definitely dated, but it is probable that major movements took place along the Soledad and Pole Canyon faults at about the same time as on south-side faults when the western San Gabriels received their last major uplift. There is some evidence also as to earliest movements along the Soledad fault. The Mint Canyon formation just north of the fault near Alpine is a very coarse fanglomerate consisting entirely of detritus almost certainly derived immediately from the south. Thus in Mint Canyon time (and maybe as early as Oligocene time) the north side of the San Gabriel Range was very steep, probably due to normal faulting which continued through the late Tertiary and culminated about middle Pleistocene time. Initial movements along the Soledad fault, then, probably took place at least as early as Upper Miocene time. While the deposition of coarse continental sediments (Mint Canyon) was taking place on the north side of the western San Gabriels, much finer marine sediments (lower Modelo) were being deposited on the south side. It thus appears likely that *the western San Gabriel Range in Upper Miocene time was a southward tilted block bounded by normal faults on the north side.*

Folding and Its Relation to Faulting

The principal folding on the south side is, like the faulting, post-Saugus and pre-terrace. Some slight southward tilting seems to have occurred in post-terrace time. The dominant fold of the region is the Merrick syncline which involves the Saugus and older formations. Subordinate folds are commonly associated with the reverse faults. North of the Lopez and Sunland faults the pre-Tertiary crystalline rocks are exposed, flanked by Saugus sediments, in an essentially anticlinal structure, here named the Little Tujunga anticline. The structure is a westward-plunging nose complicated on the south limb and down the plunge by faulting. On the anticlinal axis flat-lying Saugus gravels are present in two places, one east and one west of Little Tujunga Canyon. On the north limb, Saugus sediments dip off granodiorite at about 25° in the Gold Creek region, with the dip steepening northward until the Watt fault cuts them off. On the north limb west of Little Tujunga, Saugus sediments lie on various crystalline-rock formations at an angle of about 28°; here the flank of the major fold is complicated by subordinate folds, but northward the Saugus formation is again cut off by a reverse fault (Buck Canyon fault) striking approximately parallel to the beds and dipping in the same direction. The south limb of the Little Tujunga anticline is overturned and faulted (Lopez and Sunland faults), again with strikes and dips of these reverse faults approximating attitudes of the subjacent Saugus strata. In the Little Tujunga anticline and Merrick syncline the massive crystalline rocks would behave as competent strata underlying relatively incompetent beds (Saugus sediments). Quoting from Willis:[19]

> "Above a competent formation in an anticline, the strata are subjected to an upward push from within. They are thus stretched over the arch. * * * The fact that the relative amount of shortening decreases away from the competent bed in concentric folding has already been noted. This requires that incompetent beds in synclines above the competent bed * * * crumple or shear on the limbs of the fold * * *. An excellent example of localized shearing stress is thus afforded. The stress is greatest near the center of the limbs and dies out to nothing over the axes of the folds. At first the shear is taken up by bedding-plane slippage; but as the fold steepens, the load above the arch is concentrated on the limbs, and the shearing stress is diverted to a more nearly vertical position, until it departs so far from the bedding that slippage thereon can no longer relieve it, whereupon the beds shear through on high-angle thrust faults which form angles of 30 degrees or less with the bedding. * * * In the foothills of the northern Rocky Mountains in Alberta the incompetent Cretaceous beds shear repeatedly on the west flanks of the asymmetrical anticlines, over the more competent Paleozoic limestones."

Mason Hill[20] has contributed an excellent discussion of the possibilities of folding in massive crystalline rocks, and has presented evidence from the Little Tujunga region leading directly to his conclusion that "Massive crystalline rocks may fold in an environment (zone) of fracture." The conception here suggested of the Little Tujunga anticline seems to further clarify structural complexities of the Little Tujunga region.

There can be no doubt of the very close relationship, in origin as well as in time, of the south-side folding and faulting. All of the faults are reverse faults with the exception of occasional minor fractures, which are normal. Some of the faults have certainly been folded;

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[19] Willis, Bailey, and Willis, Robin, Geologic Structures, McGraw Hill, 1934, pp. 83, 231-34.

[20] Hill, M. L., *op. cit.*, pp. 158-159, 161.

for example, the eastern end of the Watt fault. The highly variable dips of the Watt, Buck Canyon, and Lopez faults suggests they have all been affected by folding. On the other hand, the Dillon and De Mille faults with their uniform steep dips and constant strikes do not appear to have suffered later folding, yet they are reverse faults. It seems that these differences can be reconciled if the contemporaneity of the folding and faulting be recognized. *Stresses which had resulted in some deformation in early Tertiary time reached their culmination in the middle Pleistocene with folding; then, as folding became more intense, with accompanying faulting, with a continuance of simultaneous folding and faulting some of the earlier faults were folded and finally a few high-angle reverse faults were developed.*

On the north side of the range it is necessary to explain the close association of a normal (Soledad) and reverse (Pole Canyon) fault. The Soledad fault is a normal fault developed along the contact plane between Mint Canyon sediments and the gabbro-syenite plutonics as the resistant crystalline mass was elevated. As mentioned above, initial movements took place at least as early as Mint Canyon time. The dip at first was low, possibly 30°, and of course it was a normal fault. The Pole Canyon fault, which appears to cut off the Soledad fault, was probably developed a little later as a normal fault. With the recurrence of uplift and folding in the middle Pleistocene, further movement took place along both faults, while tilting gave the Soledad fault a steeper westward dip and overturned the Pole Canyon. Thus the reverse Pole Canyon fault is really a steeply overturned normal fault.

SUMMARY OF GEOLOGIC HISTORY

1. Deposition of Placerita marine sediments in Carboniferous (?) time.
2. Mountain-building with intrusion of Rubio diorite into deformed Placerita strata in later Paleozoic (?) time.
3. Profound erosion ending the Paleozoic and possibly continuing through the Triassic and lower Jurassic.
4. Mountain-building and batholithic intrusion in the upper Jurassic (?).
5. Interval of deep erosion.
6. Deposition of Martinez marine sediments in the lower Eocene entirely across the present San Gabriel Range.
7. Initial uplift of the western San Gabriel Range in later Eocene-Oligocene time.
8. Erosion of the range to a hilly surface.
9. Uplift of the range in the middle Miocene as a southward tilted block bounded by normal faults on the north side. Beginning of faulting and folding which continued intermittently into the late Quaternary. Local extrusion of basalt.
10. Upper Miocene. Deposition of Mint Canyon continental deposits on the north and northwest sides of the range, followed by marine deposition of the upper Modelo. On the south side the deposition of marine Modelo.
11. Close of the Miocene with general uplift but only local deformation.

12. Deposition of marine Pico (lower Pliocene) beds on the south border of the range.

13. Close of Pico time with extensive uplift of the range and local deformation.

14. Deposition of continental Saugus (lower Pleistocene) beds on borders of the range.

15. Great period of mountain building in post-Saugus time (middle Pleistocene). Principal folding of upper Tertiary strata. Initial major movements along south-side faults and renewal of movements along north-side faults, in both cases accompanied by folding.

16. Vertical uplifts and slight tilting in post-Pleistocene time; recent erosion and deposition of alluvium.

MINERAL DEPOSITS AND ECONOMIC GEOLOGY

Chromite

Chromite has never been mined in Los Angeles County and no mention of the occurrence of the mineral in place can be found in state mining reports. However it has been recognized in fair-sized masses as float in a few localities near the western San Gabriel Mountains—in Bouquet Canyon, near Harold station, and in T. 4 N., R. 13 W., S. B. B. and M., near Acton station.

Chromite does, however, occur in place in the Little Tujunga quadrangle in small amounts. Two thin sections of a dark basic facies of the gabbro showed the presence of chromite. A specimen from Pacoima Creek just west of Laurel Canyon contained 17% chromite, 10% colorless augite, 58% chlorite and antigorite (from alteration of a pyroxene), and 15% apatite. Pyroxenite similar in appearance to this rock is not uncommon in the gabbro. The other specimen was a heavy ultra-basic gabbro consisting of 47% chromite, 20% altered plagioclase, 10% chlorite and antigorite, 20% apatite, and 3% chrome-spinel. In each case chromite was a primary mineral occurring in facies of the gabbro which were evidently formed by magmatic separations in basic gabbroic magma.

The ultra-basic gabbro and pyroxenite were not found in large amounts in any part of the region but, since chromite distributed through dark rocks in the field is not readily distinguished from several other dark minerals, there may be some occurrences of commercial interest. At least the possibility of small occurrences of commercially valuable chromite in the region should be recognized.

Bibl—State Mineralogist's Report XV, p. 471, and XXIII, p. 288.

Sampson, R. J., Mineral resources of Los Angeles County, State Mineralogist's Report XXXIII, July, 1937 (see p. 175 *ante,* herein).

Crystalline Limestone and Dolomite

White crystalline limestone occurs in numerous small areas up to a few hundred feet long in the southern part of the Little Tujunga quadrangle in the belt of pre-Tertiary crystalline rocks between the Dillon and Lopez-Sunland fault zones. All known occurrences have been marked on the accompanying geologic map. Several of the larger

most conveniently situated "dolomite" occurrences have been quarried. —*Baughman Dolomite deposit*—Sec. 7 and 18, T. 3 N., R. 14 W., S. B. B. and M., on a ridge northwest of Pacoima Canyon. This is a belt of white crystalline dolomite, in granite, originally reported to be 3,000 ft. long and 300 ft. wide. Actual dimensions of the outcrop are not over one-quarter those indicated. Strike is west-northwest and dip steeply toward the north.—*Haskins Dolomite deposit*—5 claims in Sec. 28, T. 3 N., R. 14 W., S. B. B. and M., in Limerock Canyon. The claims cover a discontinuous belt of white crystalline dolomitic limestone striking predominantly N. 30°-40° W. and with near-vertical dips. The rock is associated with other meta-sediments and intruded by Rubio diorite and by granodiorite. There are several dolomite "lenses" as much as 30 ft. to 40 ft. thick and 200 ft. long. This is the only deposit being worked in the Little Tujunga region at present. Limerock Canyon is exceedingly steep and narrow, making it practicable to break the dolomite from the canyon walls and allow it to slide directly down easily-constructed chutes to waiting trucks. A half-mile of rough creek-bottom road connects the quarry with the paved Little Tujunga highway.—*Ramelli Dolomite deposit*—2 claims, Sec. 17, T. 3 N., R. 14 W., S. B. B. and M., at an elevation of 2,200 ft. The deposit is about 300 ft. long and 50 ft. wide; strike is almost east-west.—*San Fernando Co.* (?) *Dolomite deposit*—Sec. 19, T. 3 N., R. 14 W., S. B. B. and M., about 3,000 ft. southeast of Pacoima dam. This occurrence has been worked in the past but not within the last few years. It is not certain that the San Fernando Co. is the owner.

All of the crystalline limestone of the Little Tujunga region probably belongs to the Placerita series of metamorphosed sediments. The occurrences are roof pendants and fragmented inclusions, all that remains of a once thick extensive limestone intruded by late Paleozoic (?) Rubio diorite and subsequently by Upper Jurassic (?) granodiorite. For a more complete discussion of the limestone see the previous section on *the Placerita meta-sedimentary series—crystalline limestone and dolomite.*

Although mineral reports refer to the deposits as "dolomite" the seven analyses given in the above section in this paper show the magnesia content as varying from 0.4% to 20.3% with an average of 11%. The rock varies chemically, then, from pure limestone to dolomite, while most of it is properly *dolomitic limestone.*

Bibl: State Mineralogist's Report, XIX, p. 165; XXIII, p. 322.
R. J. Sampson, Mineral resources of Los Angeles County, State Mineralogist's Report XXXIII, July, 1937 (pp. 202, 203, *ante*).

Feldspar-Silica

Various attempts have been made to quarry silica and feldspar from the western San Gabriel region, but with little commercial success. Small quartz veins are a possible source of pure silica, while the great masses of white syenite and anorthosite in the southern part of the Lang and northern half of the Little Tujunga quadrangles constitute an almost unlimited source of feldspar. The rock, however, is either part soda-lime and part potash feldspar or wholly the soda-lime variety, making it of little commercial value. The *Gates Chemical Co.* owns seven claims in Sec. 15, T. 4 N., R. 14 W., S. B. B. and M., elevation

about 1950 ft., near Alpine station, and for a while quarried the "white labradorite," ground it and marketed it under the name of "Gates' Cleanser." An analysis of the rock by the C. W. Hill Co. of Los Angeles is as follows:

	%
Silica	58.10
Alumina	28.27
Ferric oxide	1.03
Lime	8.60
Magnesia	0.54
Potash	1.60
Soda	0.82
Moisture	0.10
Loss by ignition	0.55
	99.61

Microscopic examination of several thin sections not far from this locality, along Soledad Canyon from Lang to Alpine, shows the rock is not labradorite, but belongs to the group of rocks mapped as *syenite*. The typical component minerals of the white syenite are andesine, microcline, orthoclase, albite, a small percentage of muscovite, and not more than 4% ferro-magnesian minerals (usually colorless augite or biotite). The very low soda in the above analysis is difficult to explain, unless the sample was a well-weathered one from which a considerable part of the soda and potash had been removed by leaching.

Bibl—Report of the State Mineralogist XXIII.

R. J. Sampson, Mineral resources of Los Angeles County, State Mineralogist's Report XXXIII, July, 1937 (pp. 203, 204, *ante*).

Gold

The earliest gold production of California came from the western San Gabriel region. Gravels in Placerita Canyon (just west of Sand Canyon) were worked by the mission priests as early as 1834, but the production was never large. In modern times gold has been obtained from a few quartz veins in the San Gabriel Mountains. Placer gold has been found in small amounts in the sands of many streams. In the region shown on the accompanying geologic map there are many evidences of prospecting, but there has been no production from lodes. Panning will yield gold in small amounts from the stream gravels in several places; Gold Canyon gravels have yielded a little, for example. Gold occurs in minute amounts in many of the plutonic rocks of the region—assays showing a few cents have been obtained from some of them—which undoubtedly have been the source rocks of the placers.

Bibl: Report of the State Mineralogist, IX, pp. 190-210; XV, pp. 473-477; XXIII, pp. 291-292.

Graphite

Reference to the accompanying geologic map shows graphite deposits are scattered, but confined to the belt of crystalline rocks between the Dillon and Lopez faults in the Little Tujunga quadrangle. Within that belt graphite is found in three general localities: 1. Vicinity of Limerock Canyon, particularly near the Kagel divide. 2. Between Pacoima Creek and lower Buck Canyon. 3. As scattered deposits within a mile to the east and northeast of Pacoima dam.

Most of the deposits are small and have never been worked, but graphite came for many years from a mine in upper Limerock Canyon, inoperative for the past few years. The mine was first operated by the American Graphite Co., of Decatur, Ill., and later by the Los Angeles Graphite Co. There are five claims in Sec. 21 and 28, T. 3 N., R. 14 W., S. B. B. and M., the mine being located near the border line of the two sections. The deposit strikes N. 30° W. for 4,000 ft. and varies in width up to 600 ft.; dip is almost vertical. A 50-ton concentration mill is located on the property. The ore has been reported to carry 7% to 15% graphite, which occurs in small flakes, on the order of size of 0.25 millimeter, disseminated in schist. The following figures taken from California Mineral Production (1927 and 1933) for several typical years indicate the general amount and variation of production. Figures are for Los Angeles County, but practically all production was from the one mine.

Year	*Pounds*	*Value*
1918	770,000	$37,225
1922	624,000	26,160
1927	76,000	13,120
1928-31	none	

Considerable difficulty was encountered in separation of graphite from the gangue because of the very small size of the graphite flakes. Probably it was this difficulty which led to the cessation of operations, since there appears to be a considerable reserve of good-grade ore accessible.

The only previous geologic work on the occurrence of graphite in the western San Gabriel Mountains was published by Burt Beverley, Jr.[21] in 1934.

The following local observations of the graphite in its association with and relation to the Placerita Meta-sediments, Rubio diorite and Upper Jurassic (?) granodiorite will serve as a basis for conclusions on origin of the graphite.

(1) In the east wall of Pacoima Canyon about 4,000 feet north of the dam is a small inclusion of graphite schist in granite; the graphite is interbedded with quartzite and is intruded by fine-grained biotite granite.

(2) Immediately north of the dam are several hundred feet of Rubio diorite-gneiss with many small irregular inclusions of metamorphosed sediments, consisting of impure crystalline limestone-dolomite, often with grains of epidote, diopside, and garnet, biotite schist, quartzite, and thin quartzose conglomerate gneiss. Attitude of the schistosity is variable but is predominantly N. 25° W. and 60° E. to vertical. The Rubio gneiss parallels schistosity of the meta-sediments and also their bedding. A thin section of the crystalline limestone consisted of 86% calcite and dolomite, 2% graphite, 5% cordierite, 6% diopside, and a few grains of iron oxides and titanite. The graphite was in small irregular flakes. Under the microscope, one specimen of graphite-sillimanite schist from the same locality was found to consist largely of reddish-brown biotite and sillimanite, with small percentages of cordierite, graphite, quartz, epidote, sericite, and colorless garnet. Biotite, graphite, and quartz were molded against blades of sillimanite.

(3) On the new forestry road being built from the Little Tujunga-Pacoima divide to Kagel Canyon graphite is exposed 4,000 feet west of the divide. The rock consists of metamorphosed sandstone and graphite schist, much crushed and altered, with dips at all angles. Rubio diorite-gneiss is in intrusive contact and both series of rocks are cut by biotite granite.

(4) The graphite mine in upper Limerock Canyon is located in a very complex belt of metamorphosed sedimentary rocks intimately intruded by Rubio diorite, usually gneissic. Gneissic banding in the Rubio, schistosity and bedding in the meta-sediments, all roughly coincide. Strike is predominantly N. 30° W., and dips are steep but vary from north to south. The metamorphic rocks form a steep westward-plunging syncline at the bend in the Lopez fault, quite probably a Quaternary structure. The rocks include Rubio diorite-gneiss, biotite schist, crystalline limestone and dolomite, yellowish and lavender quartzite, graphite schist, sillimanite schist, thin metamorphosed conglomerate, tremolite schist, and garnet-epidote rock at the granodiorite contact. The following table is the result of thin-section study of some of the typical schists.

[21] Beverley, Burt, Jr., Graphite deposits in Los Angeles County, California: Econ. Geol., vol. 29, pp. 346-355, 1934.

(a) Graphite-albite schist	
graphite—between grains of quartz and feldspar and in fractures in feldspar	10%
albite	84
rutile	1
sericite-epidote-chlorite	4
(b) Feldspar-tremolite schist	
oligoclase	75%
tremolite	20
titanite	2
biotite	2
zircon	1
(c) Graphite-tremolite schist	
tremolite	60%
oligoclase	31
microcline	3
graphite	4
titanite	2
(d) Graphite-biotite-feldspar schist	
oligoclase	60%
graphite—irregular patches, flakes, and specks	25
biotite	15
titanite and zircon	few grains
(e) Tremolite schist	
tremolite	85%
talc (?)	13
apatite, magnetite, titanite	2

Observation in the field of the distribution and occurrence of the graphite shows that it always is in close association with the Placerita meta-sediments, and is often in layers interbedded with them. Under the microscope, graphite was found to be present, in amounts varying from a few specks up to 25%, in schists of sedimentary origin. In such rocks the graphite is associated with typical contact-metamorphic minerals—formed in the border zones of calcareous and argillaceous sediments—such as garnet, epidote, diopside, tremolite, sillimanite, cordierite, and albite-oligoclase. Besides the close association with the meta-sediments, the graphite is seen to occur *only* in the belt between the Dillon and Lopez faults in which fragments of the Rubio diorite remain, and in close contact with the latter formation.

There is no particular association of the graphite deposits with the major faults or shear zones connected with such faults. All of the major faults are post-Saugus and pre-terrace, and no evidence of important faulting of earlier date was found. These Quaternary fault zones show little or no evidence of acting as channels for hydrothermal solutions. The granodiorite and granite (Upper Jurassic (?)) cut indiscriminately across meta-sediments, graphite, and Rubio diorite, while the Rubio appears to have injected the meta-sediments parallel to their bedding planes and schistosity.

Most of the metamorphism of the Placerita series took place as the result of and at the time of the Rubio diorite intrusion (late Paleozoic—Pennsylvanian (?) or Permian (?)), and it is believed that the graphite was also formed at this time. A measurable amount of hydrothermal action undoubtedly took place in the border zone in connection with the Rubio intrusion, and also probably in connection with the Upper Jurassic (?) intrusions; albite, biotite, and tremolite are minerals likely to have been formed as a result of the action of hydrothermal solutions. There are no graphite veins.

Evidence seems to support the conclusion, then, *that the graphite of the Little Tujunga quadrangle is the result of the crystallization of carbonaceous matter in sediments (Placerita) metamorphosed by diorite intrusions of late Paleozoic (?) age (Rubio) and affected to a smaller extent by the later Upper Jurassic (?) granodiorite-granite*

intrusions. Hydrothermal solutions probably effected some redistribution of the carbon as graphite near the border zones of the intrusions.

Bibl.—State Mineralogist's Report XVII, p. 318; XXIII, p. 325. R. J. Sampson, Mineral Resources of Los Angeles County; State Mineralogist's Report XXXIII, (pp. 204, 205, *ante*), July, 1937, California Mineral Production 1927 and 1933.

Petroleum

Three wild-cat wells were drilled a few years ago in the northwest corner of the Sunland quadrangle, one in Sec. 31, T. 3 N., R. 14 W., and two in Sec. 6, T. 2 N., R. 14 W., S. B. B. and M. All three were located on the south limb of the Merrick Syncline; that in Sec. 31 started in upper Pico brown sands, while the two in Sec. 6 started in sandstone at about the middle of the Modelo. The latter two were located not far from outcrops of dry-oil sandstone a few feet thick. About two miles west of Sand Canyon is the Placerita oil field where there has been some production for many years, some of it coming from basement crystalline rocks.

There is small chance of oil production in the area mapped in this paper, but the geology of the region deserves careful consideration by petroleum geologists working to the west, southwest, and northwest.

Titaniferous Iron

Small bodies of ilmenite-magnetite are of frequent occurrence in the gabbro and anorthosite of the Little Tujunga and Lang Quadrangles. In 1906 an unsuccessful attempt was made to mine such a body 200 yards from Russ Siding. The first successful production of titanium in California was in 1927 from deposits in the western San Gabriel Mountains. There is a large orebody with estimates of a reserve of 2,000,000 tons of workable titaniferous iron ore, at the head of the Tujunga (east of Little Tujunga quadrangle). Production from the area included in the accompanying geologic map has come from a series of 23 claims in T. 4 N., R. 14 W., S. B. B. and M., on the main ridge south of Soledad Canyon and between Pole Canyon and Bear Canyon (Lang quadrangle). Irregular bodies a few feet in length and width were mined, and the high-grade ore sacked and packed by mules to Soledad Canyon, thence shipped to El Segundo for the manufacture of titanium oxide. The property is inoperative at present.

Bodies of ilmenite and magnetite are commonest in the most basic facies of the gabbro, in pyroxenite, and in anorthosite. South of Iron Mountain Ridge a number of masses of ilmenite-magnetite occur in pyroxenite. At first glance the rock often appears to be entirely iron ore, but careful examination nearly always reveals that ilmenite-magnetite makes up not over 25% of the rock, with black pyroxene and greenish altered pyroxene and olivine making up the balance. Southwest of Iron Mountain on the ridge south of upper Sand Canyon are similar occurrences.

Clearly, magnetite and ilmenite are characteristic minerals in basic facies of the gabbro, the larger masses of ilmenite-magnetite being ultrabasic facies formed early in consolidation of the gabbroic magmas.

Bibl: Bulletin 101, California Mineral Production 1927, p. 61. Report of the State Mineralogist XXIII, pp. 295-313. (This includes not only an account of the San Gabriel occurrences but also brief accounts of others in the U. S. and a rather complete summary of the uses and metallurgy of titanium.)

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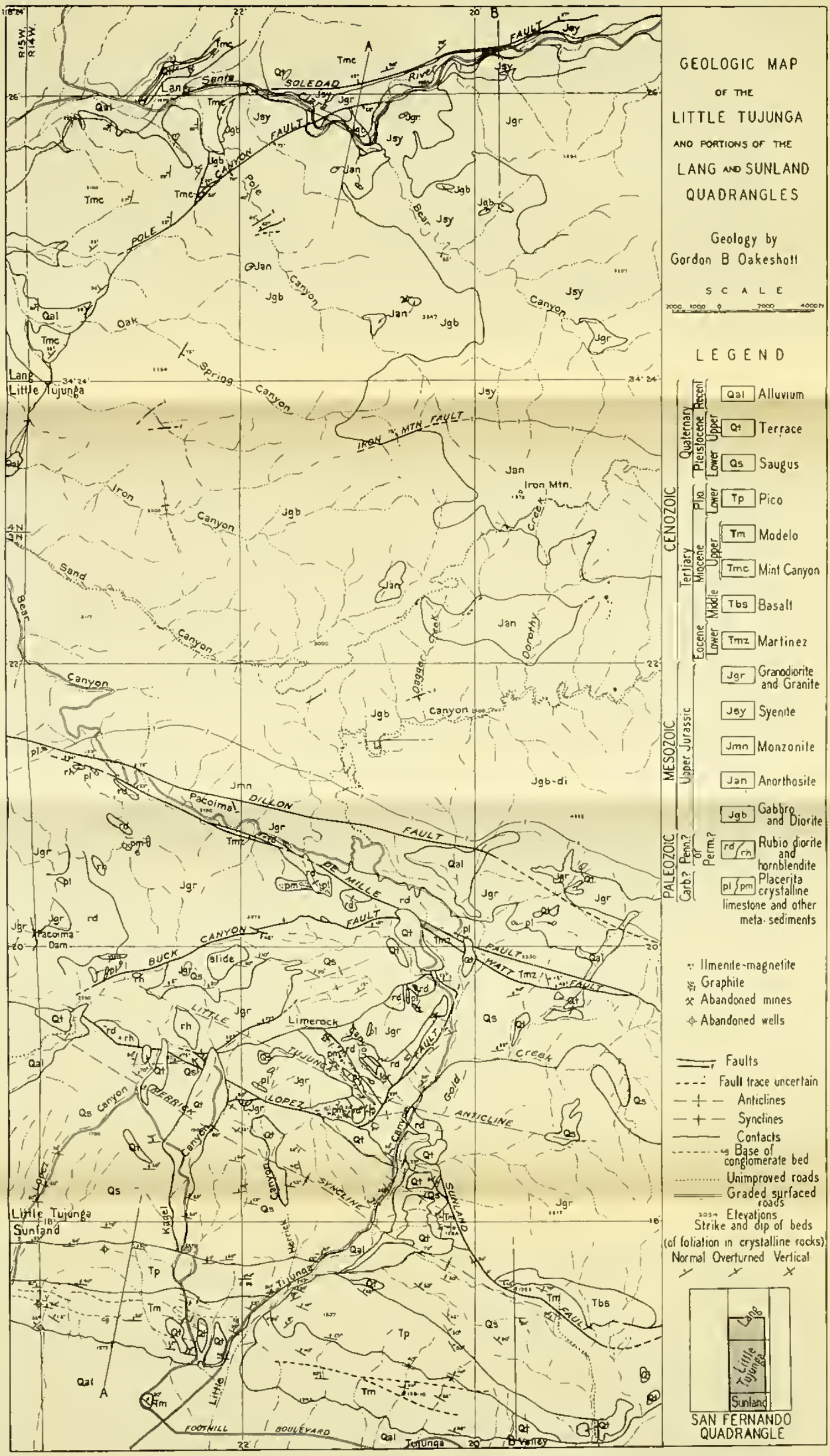

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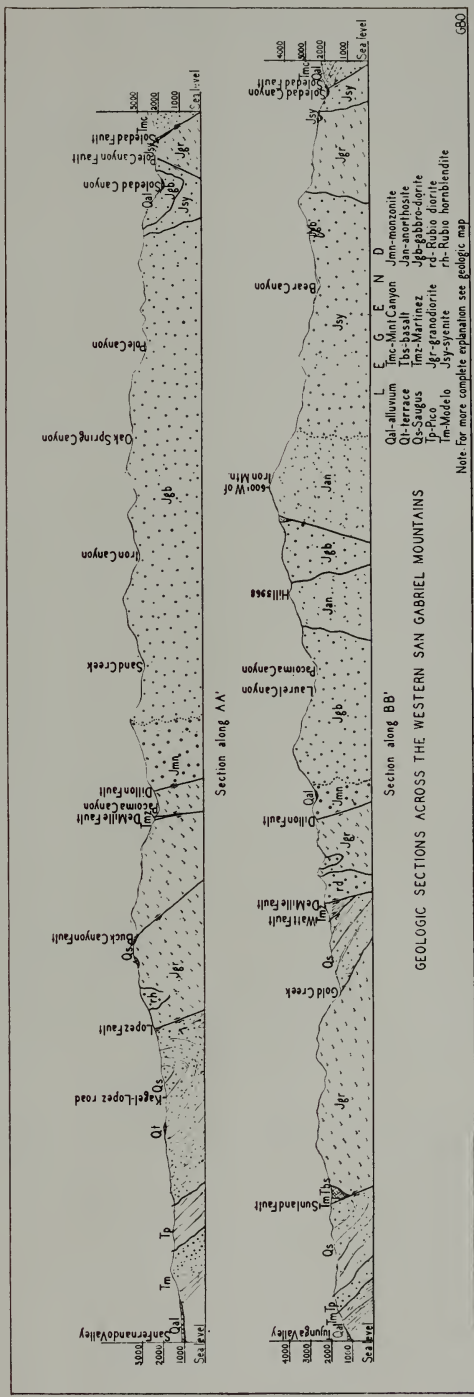
GEOLOGIC SECTIONS ACROSS THE WESTERN SAN GABRIEL MOUNTAINS
Section along AA'
Section along BB'
LEGEND
Qal-alluvium
Qt-terrace
Qs-Saugus
Tp-Pico
Tm-Modelo
Tmc-Mint Canyon
Tbs-basalt
Tmz-Martinez
Jgr-granodiorite
Jsy-syenite
Jmn-monzonite
Jan-anorthosite
Jgb-gabbro-diorite
rd-Rubio diorite
rh-Rubio hornblendite
Note: For more complete explanation see geologic map
Sea level
Sunland Fault
Gold Creek
Wall Fault
DeMille Fault
Dillon Fault
Laurel Canyon
Pacoima Canyon
Hill 3568
600' W of Iron Mtn.
Bear Canyon
Soledad Canyon
Soledad Fault
Pole Canyon
Oak Spring Canyon
Iron Canyon
Sand Creek
Buck Canyon Fault
Lopez Fault
Kagel-Lopez road
Sanfernando Valley
Jujunga Valley

Fig. 7.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

There have been no changes of personnel in the Division of Mines to be noted the past three months.

New Publications.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, April, 1937, being Chapter 2 of the State Mineralogist's Report XXXIII. This chapter contains: "Mineral Resources of Plumas County," accompanied by a geologic map. Under Special Articles, the text of the new placer-mining debris law as applied to the Klamath River, and known as the Quinn Bill passed by the 1937 legislature.

COMMERCIAL MINERAL NOTES (Nos. 169-171 inc.), May, June, July, 1937, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'CALIFORNIA JOURNAL OF MINES AND GEOLOGY.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

Data on the 1936 production of several California minerals were given in the April issue of CALIFORNIA JOURNAL OF MINES AND GEOLOGY. Copy of the complete annual report for the year is now being prepared and will shortly go to the printer as Bulletin No. 114 of the Division of Mines.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20779 GOLD in Quartz—From the Wagner Mine near Lotus, El Dorado County, California: about 20-ft. level.
Loaned by B. W. Hawes. May, 1937.

20780 SPHALERITE (ZnS)—Zinc Sulphide.
From near Carerod, Missouri.
Donor: R. F. Bibb. May, 1937.

20781 KONINCKITE—$FePO_4 3H_2O$. A hydrous iron phosphate.
From the New Idria Quicksilver Mine, New Idria, San Benito County, California. Found underground.
Laboratory, May, 1937.

20782 LIMONITE ($2Fe_2O_3.3H_2O$)—Iridescent Stalactites.
From Grizzly Bear Shaft, Goldfield, Nevada.
Donor: Hatfield Goudey. May, 1937.

20783 FAMATINITE ($3Cu_2S.Sb_2S_5$)—A copper antimony sulphide.
From Merger Shaft, Goldfield, Nevada.
Donor: Hatfield Goudey. May, 1937.

20784 OPAL (Moss). From Virgin Valley, Northwest Nevada.
Donor: W. C. Eyles. May, 1937.

20785 TURQUOISE—$CuO.3AL_2O_32P_2O_5.9H_2O$—in matrix.
From Manhattan, Nevada.
Donor: W. C. Eyles. May, 1937.

20786 VARISCITE—$AlPO_42H_2O$—in matrix.
From Candelaria, Nevada.
Donor: W. C. Eyles. May, 1937.

20787 TRAVERTINE—cut.
From Bridgeport, Mono County, California.
Donor: Dan Smith. May, 1937.

20788 CUPRITE (Cu_2O). Replacement of wood found in "Red Beds" of Jurassic Age. From San Miguel, Sandoval County, New Mexico.
Donor: H. Vincent Wallace. May, 1937.

20789 CALCITE ($CaCO_3$) Crystals in limestone. Prism shortened by pyramids. From San Vicente Creek Tunnel, Santa Cruz Portland Cement Co., Santa Cruz County, California.
Donor: Robt. Kinzie, Jr. June, 1937.

20790 TETRAHEDRITE CRYSTALS with a little famatinite on alunitized dacite. Merger 250 level. Mined in 1936. From Goldfield, Nevada.
Donor: Hatfield Goudey. June, 1937.

20791 BISMUTHINITE and GOLD. In silicified dacite. From Little Florence Shaft, Goldfield, Nevada. Mined in 1937.
Donor: Hatfield Goudey. June, 1937.

20792 PYRITE, marcasite, famatinite, gold.
Bonanza ore from stope above Clermont, 300 level. From Goldfield, Nevada. 1936.
Donor: Hatfield Goudey. June, 1937.

20793 ALUNITE. Clermont, 200 level. From Goldfield, Nevada. 1936.
Donor: Hatfield Goudey. June, 1937.

20794 FACSIMILES of various GOLD nuggets, taken from the Old Dutch Hill Mine, near Seneca, Plumas County, California, between 1880 and 1900.
Donor: O. L. Notley. June, 1937.

20795 GRANITE (Lucerne Oxford). Produced by Texas Quarries, Inc., Victorville, San Bernardino County, California.
Donor: R. M. Richter, Secty.-Mgr., Texas Quarries, Inc. June, 1937.

20796 GRANITE (Golden Vein). Produced by Texas Quarries, Inc., Victorville, San Bernardino County, California.
Donor: R. M. Richter, Secty.-Mgr., Texas Quarries, Inc. June, 1937.

20797 GRANITE (Pearl White). Produced by Texas Quarries, Inc., Victorville, San Bernardino County, California.
Donor: R. M. Richter, Secty.-Mgr., Texas Quarries, Inc., June, 1937.

20798 TURQUOISE. From Royal Blue Mine, Nye County, Nevada.
Donor: Lee F. Hand. June, 1937.

20799 BARITE ($BaSO_4$) Barium Sulphate. From the east slope of the Argus Range, 18 miles north of Trona, in Shepard Canyon, Inyo County, California, June, 1937.

20800 CINNABAR (HgS) with METACINNABAR and PYRITE. From the Mt. Diablo Mercury Mine near Clayton, Contra Costa County, California.
Donor: Mr. Cox, Supt., Mt. Diablo Mercury Mine, Bradley Mining Co. June, 1937.

20801 BOTRYOGEN, a hydrous iron magnesium sulphate. ($Fe_2O_3.2MgO.4SO_3.15H_2O$) From Redington Mine, Knoxville, Napa County, California.
Donor: Prof. Adolph Pabst. June, 1937.

20802 BARKEVIKITE, an amphibole near arfvedsonite.
Donor: Geo. L. Gary. July, 1937.

20803 FELDSPAR—clear. Between Labradorite and Anorthite. Probably from Madagascar. Laboratory specimen. July, 1937.

20804 ARAGONITE CRYSTALS. From cave at Leadfield, Titus Canyon, Death Valley, Inyo County, California.
Donor: Death Valley Curly. July, 1937.

20805 Native LEAD (Pb) with Native Copper (Cu). From Langban, Sweden.
Donor: John Melhase. July, 1937.

LABORATORY

FRANK SANBORN, Mineral Technologist

Prospecting for and development of California's mineral wealth appears to increase rather than decrease as the state grows in population. During the year, 1936, approximately 7000 samples were received and identified at this laboratory. Also, additional information and help was given to more than a hundred minors and prospectors who sought information on recovering gold and platinum from sluice box concentrates, on detecting tungsten in an ore, and many other problems.

The detection of the calcium tungstate, scheelite, by its fluorescense is very interesting and practical, and we have already given instructions and demonstrations on this method of prospecting to a number of miners. Anyone desiring information on the detection of scheelite by the ultra-violet ray may call at our laboratory where it will be given by a practical test.

Assistance in finding a market for minerals is given to those who make such a request. Those who desire to sell a mineral should submit a small sample of it to this department when help is wanted in finding buyers.

LIBRARY

J. C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the state are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:
- U. S. Geological Survey:
  - Topographic Sheets:
    - Paynes Creek, California.
    - Priest Valley, California.
    - Santa Paula, California.
  - Bulletin 887, Geophysical Abstracts 87, July-December, 1936.
  - Water Supply Paper 790, Part 10, Surface water supply of the United States, 1935. The Great Basin, California, Idaho, Nevada, Utah and Wyoming.
- U. S. Bureau of Mines Publications:
  - Manual on Geophysical Prospecting with the Magnetometer.

Information Circulars:
- 6936 Progress Report No. 3 on Investigations of Detachable Rock Drill Bits. By McHenry Mosier.
- 6937 Mining and Milling Methods and Costs at the Glass-Sand Plant of P. J. Weisel Inc., Corona, Calif. By Edmund Shaw.
- 6940 Mining Methods at the Carson Hill Mine, Calaveras Co., Calif. By John A. Burgess.

Report of Investigations:
- 3339 Progress Report, Metallurgical Division 17. Fixation of Sulphur from Smelter Smoke. By F. S. Wartman.

3340 Progress Report, Metallurgical Division 18, Studies in the Metallurgy of Copper. By F. S. Wartman and Others.
3341 Progress Report, Metallurgical Division 19, Thermodynamic Studies. By K. K. Kelley.
3344 Chloride Volatilization of Lithium from Spodumene. By Foster Fraas and Oliver C. Ralston.

Books:
Catalog for 1936 published by the Oil Weekly.
Composite Oil Field and Pipe Line Equipment.
Comprehensive Index of the Publications of the American Association of Petroleum Geologists.
Polk's San Francisco Directory for 1937.
Who's Who in Engineering, 1937—Fourth Edition—Lewis Historical Publishing Co.

Maps:
Engineers Official Map of San Francisco.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, National.

U. S. Geological Survey:
Bulletins, Water-Supply Papers, Annual Reports, Professional Papers, Circulars, Monographs, Topographic Maps and Special Publications.

U. S. Bureau of Mines:
Bulletins, Technical Papers, Economic Papers, Reports of Investigations, Information Circulars and Miners' Circulars.

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon Bureau of Mines and Geology, Corvallis.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.

Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.

Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemmologist, London.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nickel Cast Iron News, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Moscow, Idaho.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.

Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California
Western Mineral Survey, Salt Lake City, Utah
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Division of Mines' branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

7—48055

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.70
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.70
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	1.25
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.60
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.00
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.55
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	$0.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.90
Mines and Mineral Resources of Plumas County, 188 pp., paper	.60
Mines and Mineral Resources of Sierra County, 144 pp., paper	.60
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.00
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.30
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.30
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.30
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.30
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.30
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.30
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.30
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.30
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.35
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.30
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.35
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.30
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.30
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.30
April, 1928, Mines and Mineral Resources of Mariposa County	.30
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.30

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	$0.30
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.35
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.35
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.35
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.35
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.30
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.35
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.35
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.35
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.35
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.30
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.35
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.35
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.65

REPORTS—Continued

Asterisks (**) indicate the publication is out of print

	Price Postpaid
Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:	
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties	$0.90
July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543	.90
Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits	.50
April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores	.90
October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas	.50
Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation	.50
April. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits	.50
July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights	.50
October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County	.50
Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Gold Mines of Placer County, including Drag-line Dredges. Geologic report on Borax Lake, California	.50
April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum	.50
July. Mines and Mineral Resources of Calavaras County Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost	

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization	$0.50
October. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco Biennial Report of the State Mineralogist, Properties and Industrial Applications of Opaline Silica	.50
Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology' containing the following:	
January. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold	.50
April. Mineral Resources of Plumas County (with geologic map). List of preferred mineral names. New Placer Mining Debris Law	.50
Subscription, $2.00 postpaid in advance (by calendar year, only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----
January, **February, **March, April, **May, **June, **July, August **September, **October, **November, **December, 1921	Free
January, February, March, April, May, June, **July, **August, September, **October, **November, December, 1922	Free
January, February, **March, **April, May, **June, **July, August, September, **October, November, **December, 1923	Free
January, February, March, April, May, June, **July, August, September, October, November, December, 1924	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1925	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1926	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1927	Free
January, February, March, April, **May, June, July, August, September, October, **November, **December, 1928	Free
January, February, March, April, May, June, July-August-September, October-November-December, 1929 (Published quarterly beginning July, 1929)	Free
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free
January-February-March, April-May-June, July-August-September, 1931	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1932	Free
January, February, March, 1933	Free
April, May, June, 1933	Free
July, August, September, 1933	Free
October-November-December, 1933	Free
January-February-March, 1934	Free
April-May-June, 1934	Free
July-August-September, 1934	Free
October-November-December, 1934	Free
January-February-March, 1935	Free
April-May-June, 1935	Free

BULLETINS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	$0.10
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

Vol. 33 OCTOBER, 1937 No. 4

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIII

STATE DIVISION OF MINES
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SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geological Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).
3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District. Mr. Chas. V. Averill, District Mining Engineer, is engaged on investigations for a special report on gold dredges in the Redding district.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field Division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

MINERAL RESOURCES OF THE RESTING SPRINGS REGION, INYO COUNTY*

By R. J. SAMPSON, Mining Engineer

Location and General Features

The Resting Springs area, comprising some 300 square miles, is in the southeastern corner of Inyo County, approximately 300 miles northeast of Los Angeles. It is bounded on the northeast by the State of Nevada and on the south by San Bernardino County. Death Valley lies just to the northwest.

Within its boundaries are two principal mountain ranges, the Nopah Range on the east and the Resting Springs Range in the center. Between these two lies the Chicago Valley, while the Amargosa Valley is at the western foot of the Resting Springs Range. Elevations range from about 1600 in the valleys to 5000 in the Resting Springs Range, and 6415 in the Nopah Range.

The climate is similar to that of the south end of Death Valley, very hot and extremely arid. Temperatures range up to 120° in the summer and may go above 80° at midday in winter. Night temperatures in winter, however, may drop to several degrees below freezing. Annual rainfall averages less than two inches.

The principal towns are Shoshone, Zabriskie, and Tecopa, all stations on the Tonopah & Tidewater Railroad which traverses the full length of the district. State and county highways make all parts of the area readily accessible.

Mineral Deposits

While considerable prospecting has been done within these boundaries, but few commercial mineral deposits have been developed. Minerals which have been commercially produced are lead, silver, zinc, and talc. In the following pages these deposits are described in alphabetical order.

LEAD, SILVER, ZINC

Blue Dick Mine is in the Kingston range of mountains, near the San Bernardino County line, southeast of Tecopa, California.

Lenticular masses of lead carbonate occur along a fissure in limestone. Development consists of 500 ft. of tunnels and drifts. Idle.

Bibl: State Mineralogist's Reports XV, p. 89; XVII, p. 283; XXII, p. 479.

Gunsite Mine is in the Nopah Range, 7 miles east of Tecopa. Elevation 2350 ft. Owner, *Tecopa Consolidated Mining Co.;* L. D. God-

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* This economic report is intended to supplement the geologic discussion by John C. Hazzard, "Paleozoic Sections in the Nopah and Resting Springs Mountains, Inyo County, California," also published in this issue of the JOURNAL.

shall, vice president and general manager, 722 South Oxford Ave., Los Angeles.

There is a railroad from this property and the Noonday to Tecopa, where it connects with the Tonopah & Tidewater.

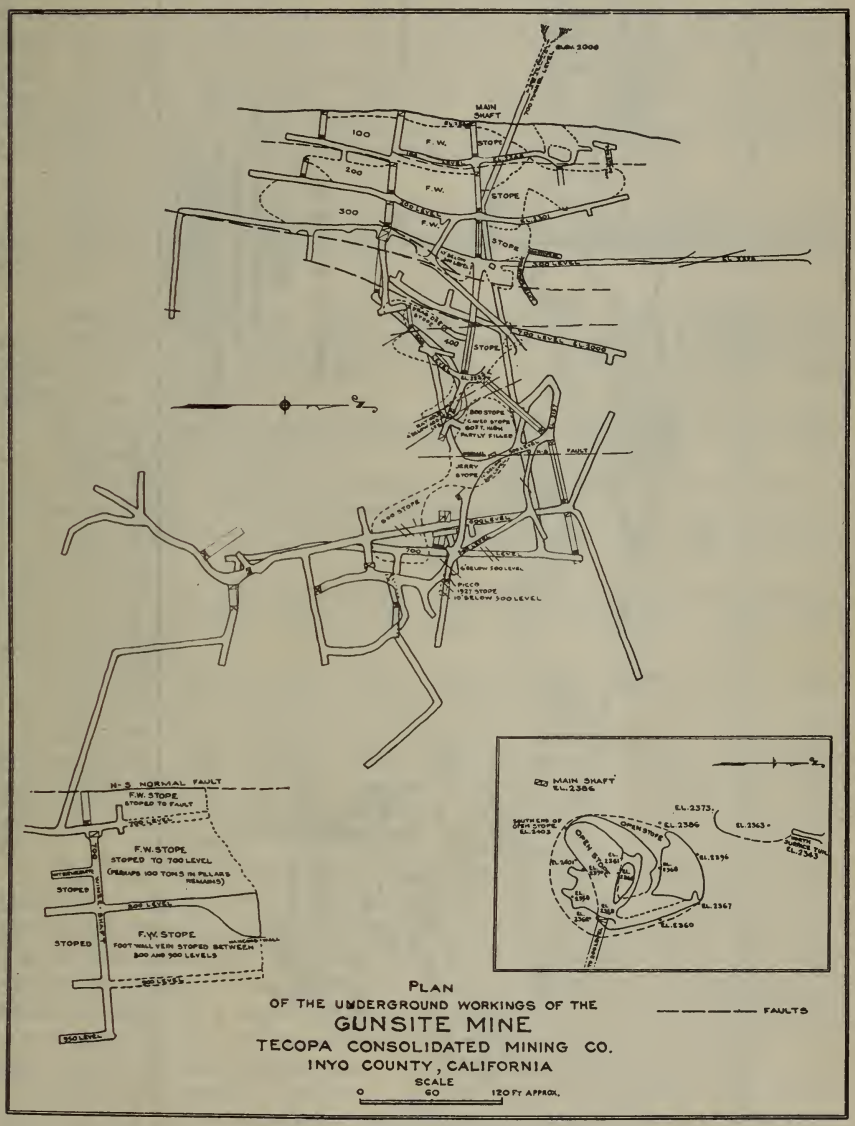

FIG. 1. Plan of Gunsite Mine.

The country rock is the Noonday dolomite which is underlain by Algonkian shales and conglomeratic sandstones. The ore occurs as irregular lenses of lead carbonate and galena along a fissure in the dolomite, which strikes N. 45° W. and dips 35° to 50° NE. A series of N.-S. faults, dipping from 35° to 55° W., show displacement of the orebodies up to 30 ft.

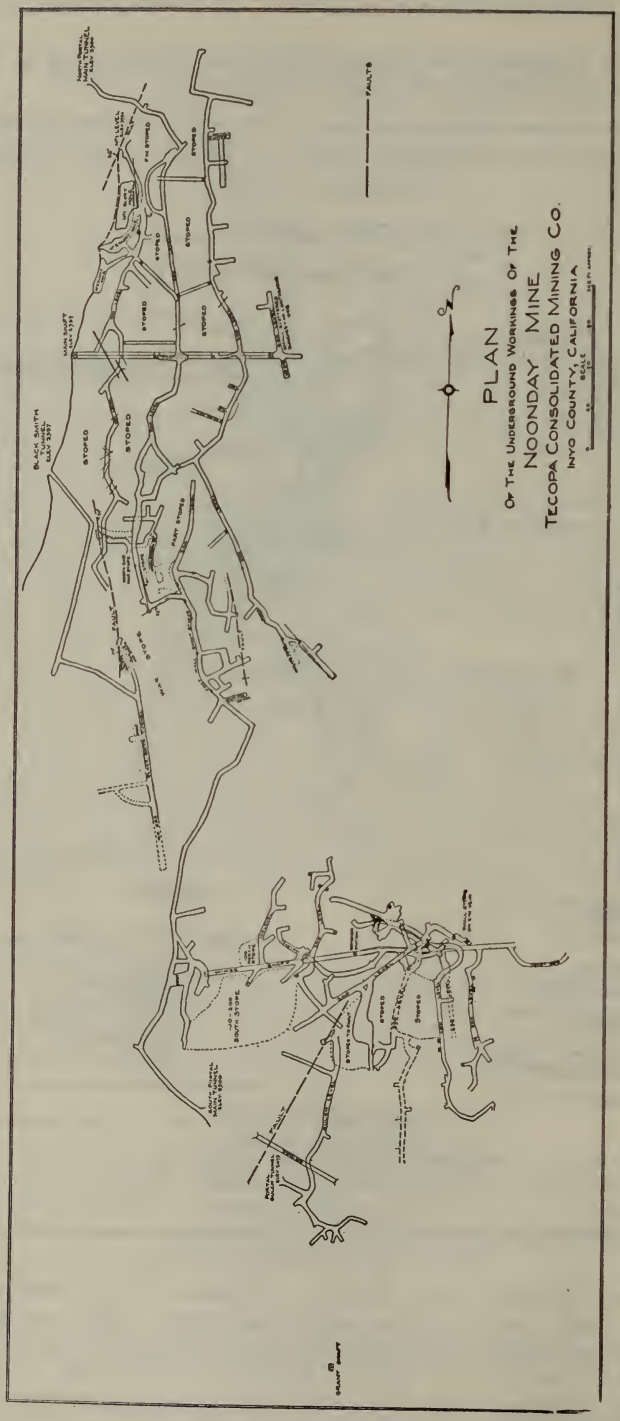

FIG. 2. Plan of Noonday Mine.

Development, consisting of several thousand feet, is shown on the map published herewith.

During its period of operation, 1912-1928, some 55,000 tons of ore was shipped to the smelters. This ore ranged from $6 to $50 per ton in value. The average assay value of all shipments was: Gold .077 oz., silver 9.38 oz., lead 7.84%. Shipments of the lower-grade ore were made possible through cooperation of the smelter which needed this class of feed in its charges. All of this ore was taken from one shoot, as indicated on the map. Since the company ceased its operations, an occasional carload has been shipped by leasers.

Idle at present.

Bibl: State Mineralogist's Reports XV, pp. 95-96; XVII, pp. 286-287; XXII, p. 485; Report of the Director of the Mint, Precious Metals in the U. S., 1883, p. 166.

Noonday and Grant Mines are approximately 1½ miles southeast of the Gunsite Mine. They are also owned by the *Tecopa Consolidated Mining Co.,* which is controlled by Dr. L. D. Godshall, 722 South Oxford Los Angeles.

An 8-mile railroad spur track connects the mine with the Tonopah and Tidewater at Tecopa.

The Grant adjoins the Noonday on the south and the out-crop of the fissure filling is readily traceable between the two.

Shipments from the two properties have aggregated approximately 93,000 tons.

The Noonday produced 85,000 tons ranging in value from $10 to $75 per ton. Average value of all shipments: Gold .091 oz., silver 7.29 oz., lead 15.39%.

The Grant shipped 8000 tons with values from $8 to $50 per ton: Average, gold .064 oz., silver 5.87 oz., lead 11.05%.

The workings of these mines are in the same fissure as those of the Gunsite Mine. The country rock is the Noonday dolomite. Here the vein strikes N. 40° W. and has an average dip of about 45° NE., although locally it flattens to 30° and, in places, may dip as steeply as 60°.

The main orebodies occur along a series of N.-S. fractures in the dolomite. In places the width may be 30 ft. or more. A series of N.-S., steeply-dipping to vertical faults have probably influenced the position of the shoots in the vein. Two principal ore-shoots have been mined, one at the main shaft, the other at the winze. These may, in places, consist of a series of over-lapping lenses, but the zone of the occurrences is more or less continuous within the shoots. The ore consists largely of lead carbonates with some unoxidized galena.

The development, consisting of a shaft to the 400-ft. level and a 600-ft. winze below the tunnel, is shown on the accompanying map.

Equipment consists of gasoline hoists at the shaft and winze of the Noonday. A 25-h.p. gas engine operates a two-drill compressor at south portal of the tunnel. The Grant shaft is equipped with 35-h.p. gasoline hoist. Idle at present.

Bibl: State Mineralogist's Reports XV, pp. 103-104; XVII, pp. 291-293; XXII, pp. 491-492.

Redwing Mine (lead-zinc) is situated in the Resting Springs district, 4 miles northwest of Shoshone on the west slope of the Resting Springs mountains. Owner, R. J. Fairbanks, Shoshone, Calif. Idle.

Bibl: State Mineralogist's Reports XV, p. 106; XXII, p. 497.

Silver Rule Mine (lead-silver-zinc) is situated in the Resting Springs district, on the southwest slope of the Kingston range, 17 miles east of Morrison's siding, on the Tonopah & Tidewater Railroad. Holdings comprise 12 claims. Owner, *Pacific Lead & Silver Mining Co.,* 711 Sun Bldg., Los Angeles; A. J. Jarmuth, president; C. A. Malburg, superintendent.

The ore occurs as irregular lenses of lead carbonate and galena along a fissure in limestone. The vein strikes NW. and dips 75° N. The width of ore developed is from 3 ft. to 15 ft. The ore is reported to contain 10 to 20 oz. in silver per ton, 20 to 40% lead, and 7 to 10% zinc.

Development consists of 4 tunnels. The upper tunnel (No. 1) is 220 ft. in length, and 75 ft. vertically below is No. 2 tunnel, 400 ft. in length, with a raise from No. 2 in ore to No. 1. At 560 ft. vertically below No. 2, a tunnel is driven as a cross-cut 300 ft. southwest, with a drift 200 ft. west on a fracture in the limestone. At an elevation of 3410 ft. (No. 4) lower working tunnel is driven south 300 ft. Idle.

Bibl: State Mineralogist's Reports XV, p. 104; XVII, p. 365; XXII, p. 500.

Tecopa Consolidated Mining Co., Dr. L. D. Godshall, 722 South Oxford Ave., Los Angeles, vice president and general manager, owns the Gunsite, Noonday, Grant, War Eagle, Columbia, and Alexander Mines. They operated these properties from 1912 to 1928. The ore was hauled over their own railroad about 8 miles to Tecopa where it was delivered to the Tonopah & Tidewater tracks.

Shipments aggregated approximately 156,000 tons from which there was recovered $3,000,000. A large portion of this ore carried such high percentages of iron and lime that credits for these materials at the smelter amounted to more than the smelting charges.

Description of the mines will be found under the various names in this report.

War Eagle Mine is situated in the Resting Springs district on the western slope of the Nopah range of mountains, 9 miles southeast of Tecopa and one mile south of the Grant Mine. Elevation 2600 ft. Owner, *Tecopa Consolidated Mining Co.;* Dr. L. D. Godshall, vice president and general manager, 722 South Oxford Ave., Los Angeles.

These workings are on the continuation of the Gunsite-Noonday-Grant vein. The strike is N. 40° W. and dip is 50° NE. The orebodies developed are formed along a series of N.-S. fault fractures in dolomitic limestone. The ore consists of lead carbonate with some unoxidized galena. Shipments, consisting of 5000 tons, made from the property averaged gold 0.298 oz.; silver 4.47 oz.; lead 11.89%. Some shipments carried as much as 0.60 oz. of gold per ton.

Development consists of a cross-cut tunnel driven N. 60° E. 450 ft. to the vein, with a drift south 400 ft. on the vein, and north 150 ft. At 100 ft. south of the cross-cut tunnel, a winze has been sunk on the vein

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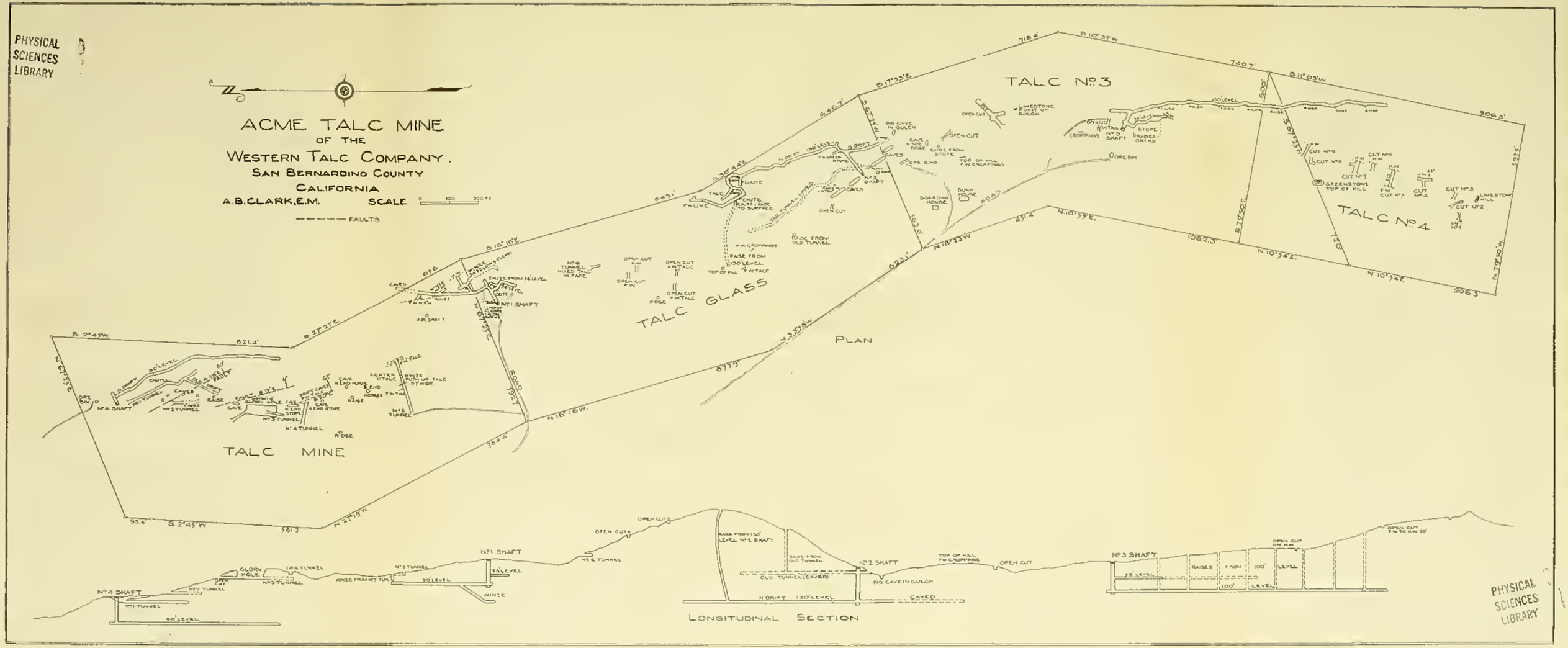

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Accompanying report by R. J. Sampson, October, 1937.

to a depth of 100 ft., with levels at 50 ft. and 100 ft. The lateral development on the vein at these levels is about 300 ft. The ore-shoot developed was 100 ft. in length and from two to 6 ft. in width, stoped from tunnel level to the surface.

Equipment consists of 40-h.p. Fairbanks-Morse diesel engine; 9 by 8 in. Ingersoll-Rand compressor. Ore was hauled by trucks 1¼ miles to the railroad. Idle.

Bibl: State Mineralogist's Report XXII, pp. 503-504.

TALC

For some years talc has been shipped from this area into Los Angeles, where it has been used in the manufacture of paint, paper, and rubber, and also in ceramics. Three separate deposits have been developed.

Acme Talc Deposit, comprising 7 patented claims and 4 locations, is in Sec. 4, T. 19 N., R. 8 E. and Secs. 32 and 33, T. 20 N., R. 8 E., in the Kingston Mountains, some 15 miles southeast of Tecopa, elevation about 3000 ft. Owner, *Western Talc Co.;* F. H. Savell, president, 1901 East Slauson Ave., Los Angeles. A. B. Clark is in charge of mine operations.

The patented claims are Snow Goose No. 1, 2 and 3, Talc Mine, Talc Glass, Talc No. 3, and Talc No. 4.

The talc occurs along the contact of dolomitic limestone and greenstone. The dolomite forms the hanging wall, the greenstone is on the foot. The strike of the deposit is N.-S., dip 50°-55° E. The talc occurs as a series of overlapping lenses along this contact, which, in places, is up to 75 ft. in width.

Development is distributed over more than a mile in length of this zone and the lenses are up to 34 ft. wide, with an average width of 10 ft. The talc is white in color and free from grit and lime.

The property has been developed by 4 shafts, and numerous tunnels and open-cuts. The accompanying map is not up-to-date, much work having been done which is not shown thereon.

Shaft No. 1, near the north end of the Talc Glass claim, sunk 100 ft. on 55° inclination; on 58-ft. level, drift S. 100 ft.; on 90-ft. level, drift N. 340 ft. A winze has been sunk to the 134-ft. level at the east end of a cross-cut which is 50 ft. N. of the shaft.

Shaft No. 2, approximately 1300 ft. south of No. 1, has been sunk 158 ft. on about a 50° inclination. On the 130-ft. level a drift has been driven 630 ft. N. Above this there are several hundred feet of drifts, raises, and cross-cuts, most of which are now caved. It is reported that the talc was mined 20 ft. in width here.

Shaft No. 3 on Talc Claim No. 3 is 850 ft. south of No. 2 shaft. It has been sunk 100 ft. on a 55° inclination. On the 100-ft. level drifts have been driven N. 100 ft. and S. 1000 ft. Mining is carried on from a sub-level some 65 ft. below the surface. Eight raises have been holed through to the surface. The average width of talc in these workings is estimated to be 10 ft.

Shaft No. 4 is on the Talc Mine claim some 1300 ft. north of shaft No. 1. It has been sunk to a depth of 90 ft. On the 80-ft. level a drift has been driven S. 600 ft. This drift will, in the next 200 ft., reach a

point below a glory hole which was worked from tunnel No. 1, which is 10 ft. lower than the collar of No. 4 shaft. This glory hole is 100 ft. long, 30 ft. wide, and 15 ft. deep.

It is estimated that these workings have blocked out a large tonnage of talc. At shaft No. 3 alone, it is believed that 50,000 tons are available in present workings.

Equipment at No. 3 shaft consists of 135-cu. ft. compressor, belt-driven by gas engine; 30-h.p. gas-engine hoist. Ore is raised in 1½-ton skip to 2 bins having a capacity of 100 tons.

At No. 6 tunnel there is a 110-cu. ft. portable compressor. No. 4 shaft is equipped with a 30-h.p. gas hoist and 90-cu. ft. compressor.

The camp consists of cook house, bunk house, two residences, and two tent houses.

Shipments are made at the rate of about 10,000 tons per year. The talc is hauled 6 miles to Acme, a station on the Tonopah & Tidewater Railroad. Some 15 men are employed.

Sierra Talc Co., P. H. Booth, president; Franklin Booth, secretary, 333 West 2d St., Los Angeles, has a deposit of talc in the Kingston Range, 23 miles southeast of Tecopa.

The deposit is on a contact, having a dolomite hanging wall and a diorite footwall. The strike is E.-W. and it dips flatly to the north.

Development consists of a tunnel driven W. 210 ft.; 60 ft. above is another tunnel W. 190 ft. At face of this tunnel a raise has been holed through to surface from lower tunnel. The tunnels are also connected by two other raises.

In these workings, talc 9 ft. wide and 90 ft. long has been exposed. It is pure white and free from grit. It is apparently very high-grade material.

One thousand feet east of these workings and approximately 100 ft. higher, a tunnel has been driven 45 ft. N. as a cross-cut; at 25 ft., a drift E. 110 ft. The entire 45 ft. of cross-cut is in talc. Raises from the drift at 10, 35, 50, 65, 85 and 105 ft. from cross-cut connect with a glory hole above. This glory hole is approximately 150 ft. long, up to 15 ft. wide, and 30 ft. deep.

John Lisle, of Tecopa, mines and hauls the material to the railroad under contract.

GEOLOGIC BRANCH

CURRENT NOTES

OLAF P. JENKINS, Chief Geologist

The following geologic report on the "Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California," contributed by John C. Hazzard, has been carefully read by Dr. Levi F. Noble,* who originally suggested the study and who now makes the following introductory remarks:

* Address: Valyermo, California. Geologist, U. S. Geoligical Survey.

"During the past five years the United States Geological Survey has been making a study of the geology of Death Valley. The area under investigation, designated the Death Valley area, includes all the Death Valley National Monument south of Emigrant Wash and Boundary Canyon, and the territory east of the Monument as far as the Nevada-California state line. It contains the deeper parts of the Amargosa and Death Valley troughs; the Nopah and Resting Springs Mountains east of Amargosa Valley; the Funeral, Black, Greenwater, and Ibex Mountains between Amargosa and Death Valleys; and the Death Valley slopes of the Panamint, Owlshead, and Avawatz Mountains west of Death Valley.

"At the time the investigation was begun little was known definitely concerning the age, character, and sequence of the rocks in the area. Without this stratigraphic knowledge it was impossible to make progress with a study of the structure. Detailed sections of the Paleozoic and Tertiary rocks were particularly needed because the rocks of these two geologic time divisions cover more of the area than the rocks of all other divisions combined, and are involved in nearly all the major structural features.

"Three mountain ranges in the Death Valley area expose a fairly complete sequence of Paleozoic rocks: the Nopah and Funeral Mountains expose a sequence reaching from the base of the Lower Cambrian up into the Carboniferous; and the Panamint Mountains expose the same sequence plus thousands of feet of Carboniferous beds younger than those in the Nopah and Funeral Mountains. In the Panamint Mountains, however, and to a somewhat lesser degree in the Funeral Mountains, the Paleozoic strata are so badly broken by faulting and folding that a section can be pieced together only with great difficulty. The structure of the Nopah and the associated Resting Springs Mountains, although considerably broken by faulting, is relatively simple. The mountains have the attitude of monoclinal fault blocks in which the strata strike a little west of north and dip eastward and northeastward. Tertiary lavas sometimes lie upon the back slope of the Resting Springs block, but the Nopah Mountains are wholly bare of them. Thrust faulting complicates the structure at the north end of the Nopah Mountains and at the extreme southwestern end, but elsewhere the general monoclinal structure of the range makes it readily feasible to piece together sections measured at different places into a composite whole. For this reason I recommended the Nopah section to Mr. Hazzard for study.

"As a contribution to the geology of Death Valley Mr. Hazzard's paper is of great importance—directly to the stratigraphy, and indirectly to the structure. His careful measurement, description, and subdivision of the Paleozoic rocks has supplied a yardstick that enables the geologist to recognize separate formations wherever they crop out in the area and to assign them to their proper position in the Paleozoic sequence. As a geologist working in Death Valley I can testify to the accuracy and value of his work. Mr. Hazzard's section is the more helpful for the abundance of lithologic detail which he has incorporated in the text. Particularly helpful are his descriptions of persistent and distinctive horizons that can be used as 'marker beds' in areal mapping.

Examples are the Noonday dolomite; the 'Zabriskie quartzite' and the bed of 'algal limestone' in the Wood Canyon formation; the Eureka quartzite; and the Ely Springs dolomite. These and many other 'marker beds' of Hazzard's section are easily recognizable in the Death Valley area.

"One of the interesting faults in the area is a fault in Chicago Pass at the north end of the Nopah Mountains. This fault, which I have designated the Chicago Pass thrust, resembles in all its features the Wheeler Pass thrust described by Longwell 20 miles northeastward across Pahrump Valley. Mr. Hazzard's Paleozoic section has been of the greatest assistance to me in the study of the fault. It has enabled me to determine definitely the age of the beds involved in the faulting and to state with assurance that, as in the Wheeler Pass thrust, Lower Cambrian beds are thrust from the northwest over Carboniferous; that the stratigraphic throw of the fault exceeds 13,000 feet; and that the fault is in all probability a part of the Laramide orogeny described by Longwell at Spring Mountain. I cite these conclusions as an example of the immediate applicability of Mr. Hazzard's section to structural problems.

"Another feature of Mr. Hazzard's paper upon which it seems appropriate to comment is his discussion of the Noonday dolomite. This formation is an algal dolomite of a type common in the pre-Cambrian rocks of the Death Valley area. Curiously, these algal dolomites of the pre-Cambrian type (yellowish to brownish-buff-weathering dolomites containing iron) are also characteristic of the Johnnie formation conformably overlying the Noonday. Yet the Noonday dolomite at the base of the Paleozoic section overlies the most profound unconformity in the region. In other words, the Noonday and Johnnie formations are Algonkian in lithology but are Lower Cambrian in stratigraphic position. Therefore it is evident that Algonkian conditions of deposition did not cease with the mountain-making revolution portrayed by the great unconformity, but continued into Lower Cambrian time, if, indeed, the Johnnie and Noonday are Lower Cambrian. It is worthy of note that these two formations contain no fossils, so far as is known. It is expected that further study will throw light upon the problem, which is complicated in the Death Valley area by the fact that at places both the Noonday and Johnnie formations appear to have been thrust over an erosion surface cutting across older rocks. That the Noonday and Johnnie are everywhere conformable in attitude with overlying Lower Cambrian beds is an incontrovertible fact. If a break exists, it is an erosion surface of the disconformable type, and therefore exceedingly difficult to detect.

"In addition to its applicability to Death Valley geology, Mr. Hazzard's section throws much light upon the Paleozoic history of the general region and supplies a standard of comparison for Paleozoic rocks exposed elsewhere in that region which have been described by Hewett, Knopf, Longwell, Nolan, and Westgate. Because of its accuracy and detail it is destined to constitute the type lower Paleozoic section for much of southern Nevada and southeastern California for many years to come."

LEVI F. NOBLE.

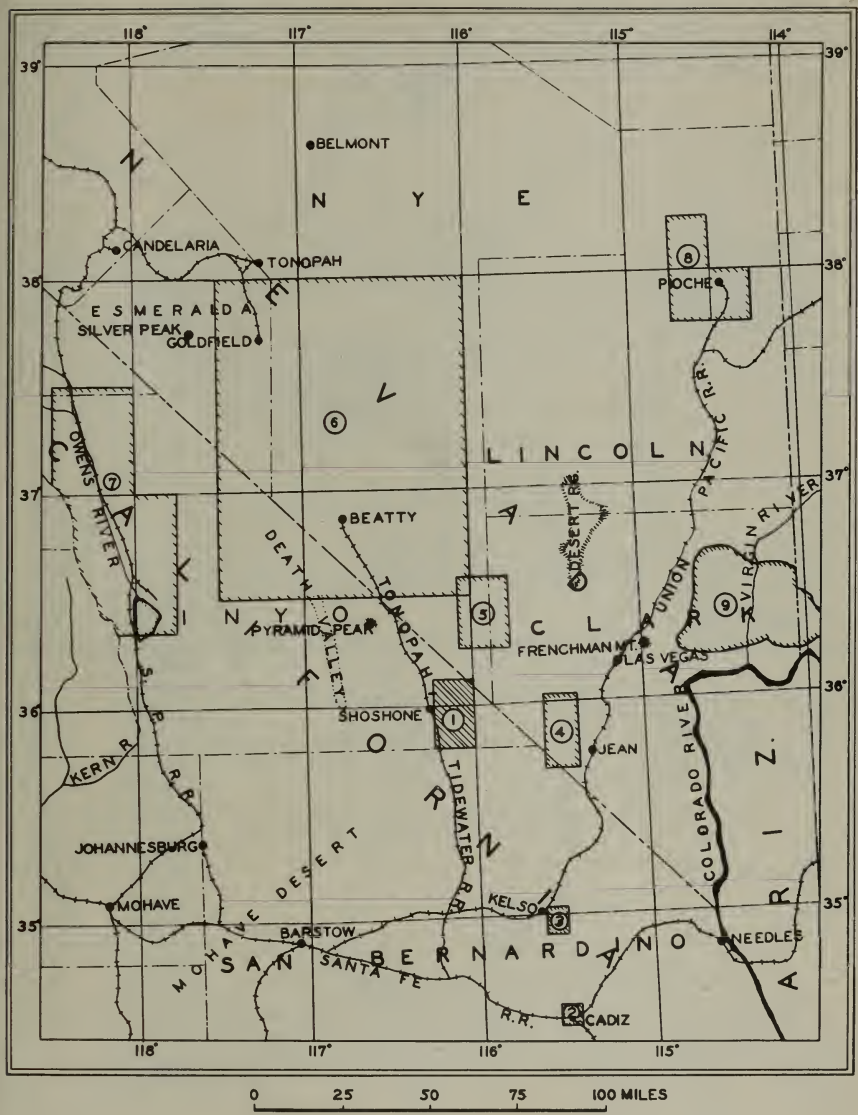

FIG. 1. Index map of southeastern California and southern Nevada.
(1) Nopah-Resting Springs Mountains, California.
(2) Marble Mountains, California (Hazzard, 1933).
(3) Providence Mountains, California (Hazzard and Mason, 1936a).
(4) Goodsprings quadrangle, Nevada (Hewett, 1931).
(5) Northwest portion of Spring Mountain, Nevada (Nolan, 1929).
(6) Southwestern Nevada and eastern California (Ball, 1907).
(7) Inyo Mountains, California (Knopf, 1918).
(8) Pioche district, Nevada (Westgate, 1932).
(9) Muddy Mountains, Nevada (Longwell, 1928).

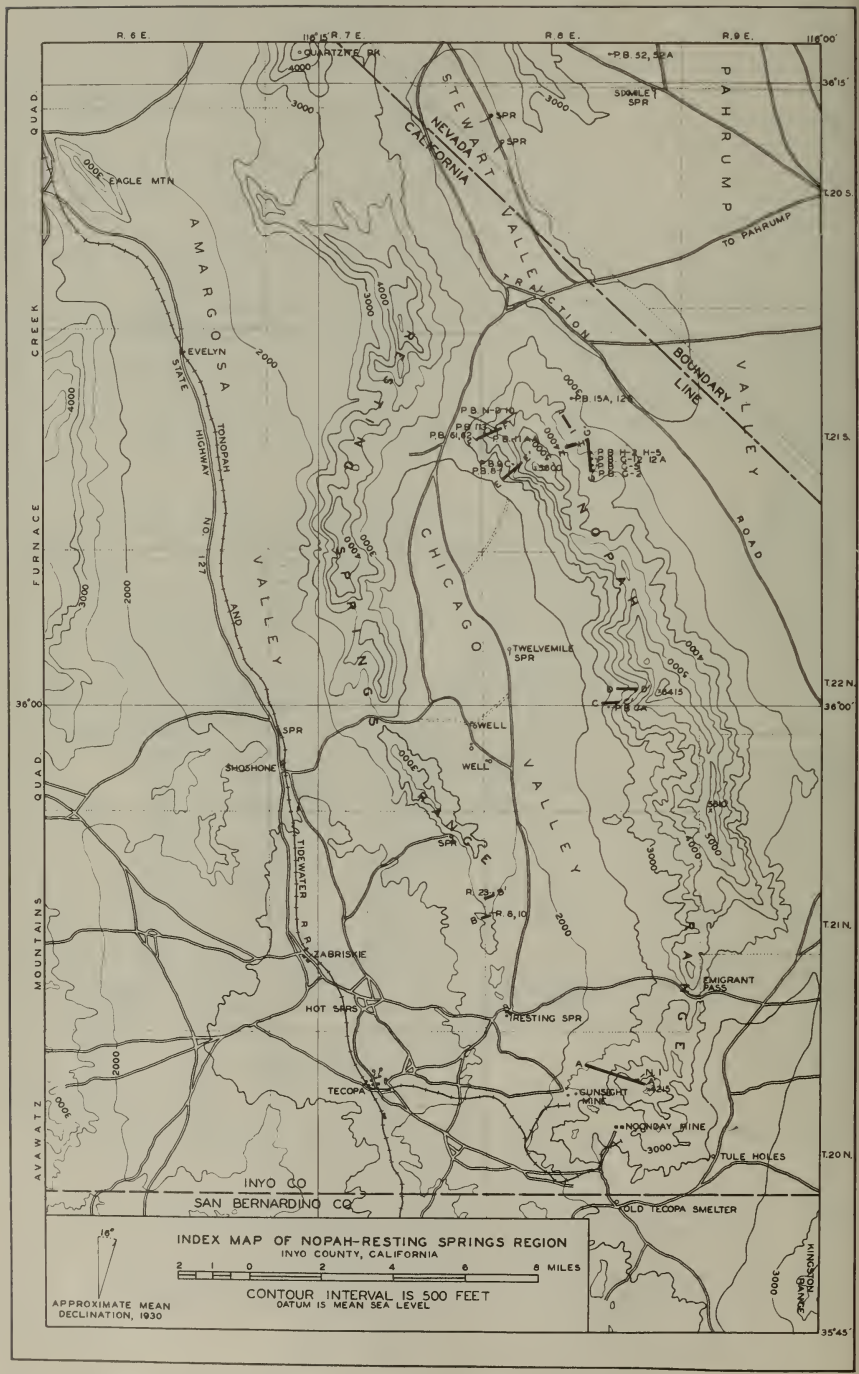

FIG. 2. Index map of Nopah-Resting Springs region showing location of measured sections and important fossil localities.

PALEOZOIC SECTION IN THE NOPAH AND RESTING SPRINGS MOUNTAINS

INYO COUNTY CALIFORNIA

JOHN C. HAZZARD 1937

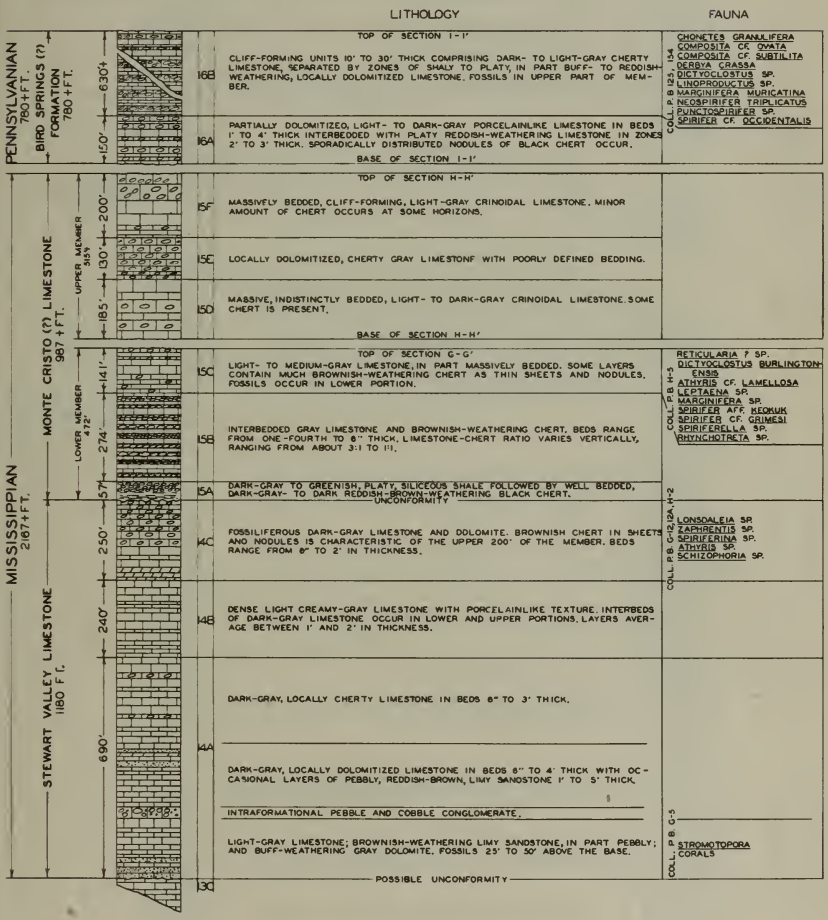

FIG. 3a. Columnar section of Paleozoic rocks of the Nopah-Resting Springs Mountains (Pennsylvanian, and Mississippian).

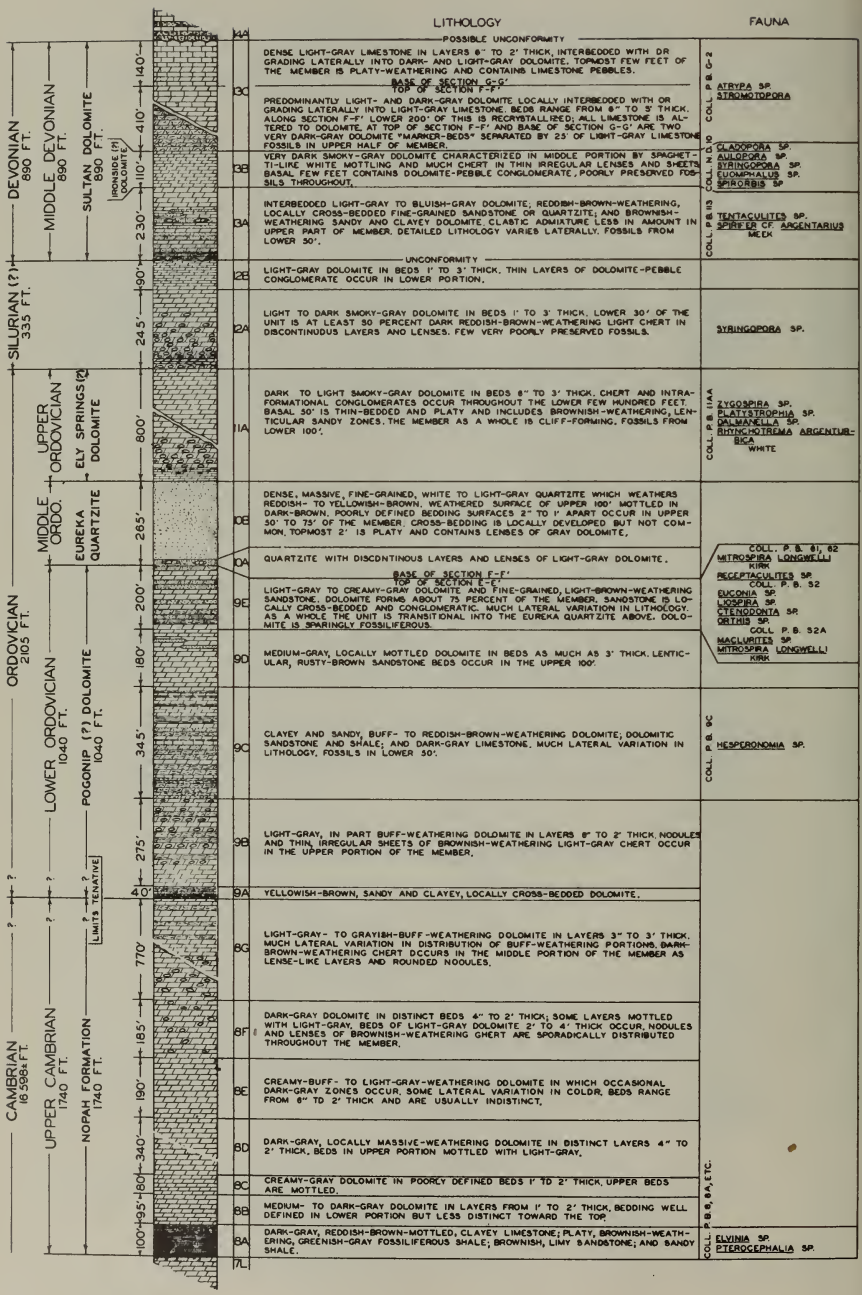

FIG. 3b. Columnar section of Paleozoic rocks of the Nopah-Resting Springs Mountains (Devonian, Silurian, Ordovician, and Upper Cambrian).

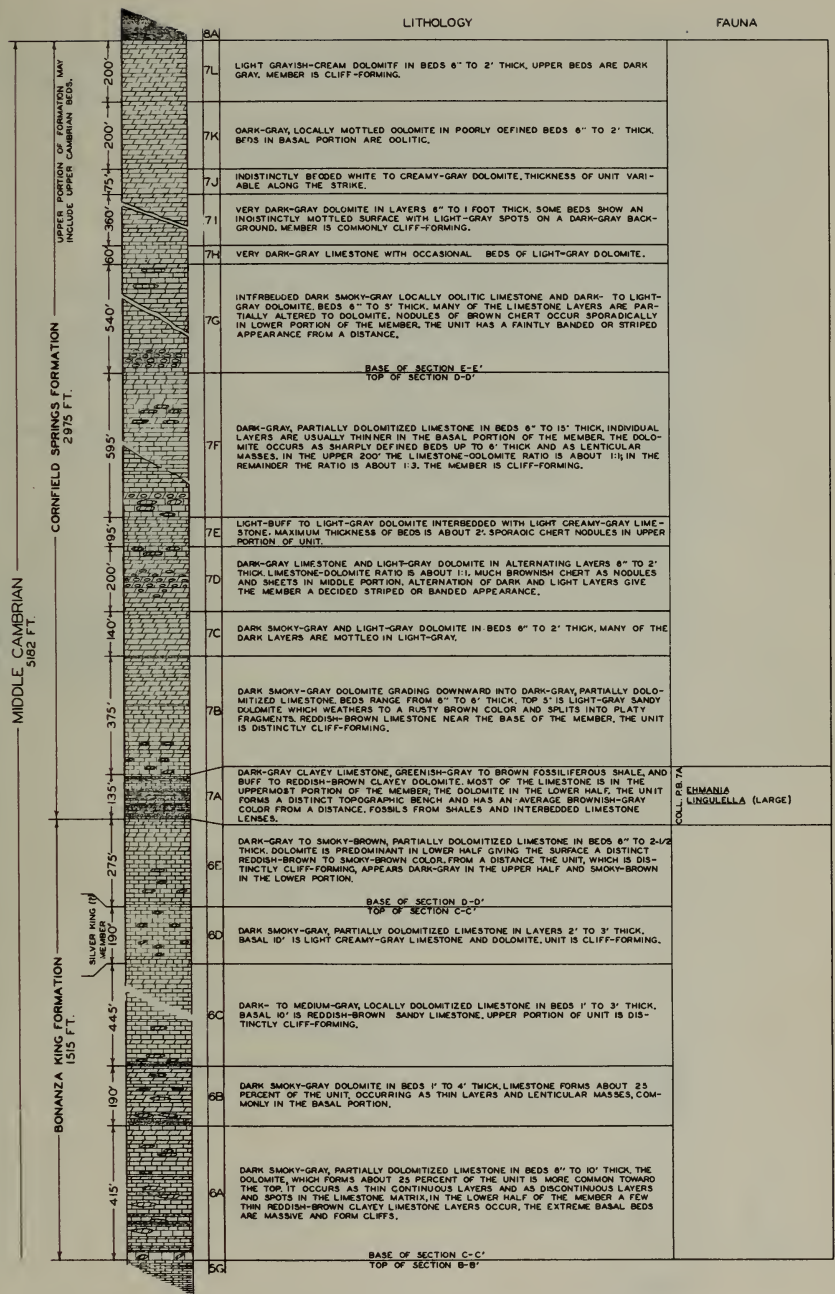

FIG. 3c. Columnar section of Paleozoic rocks of the Nopah-Resting Springs Mountains (Middle Cambrian).

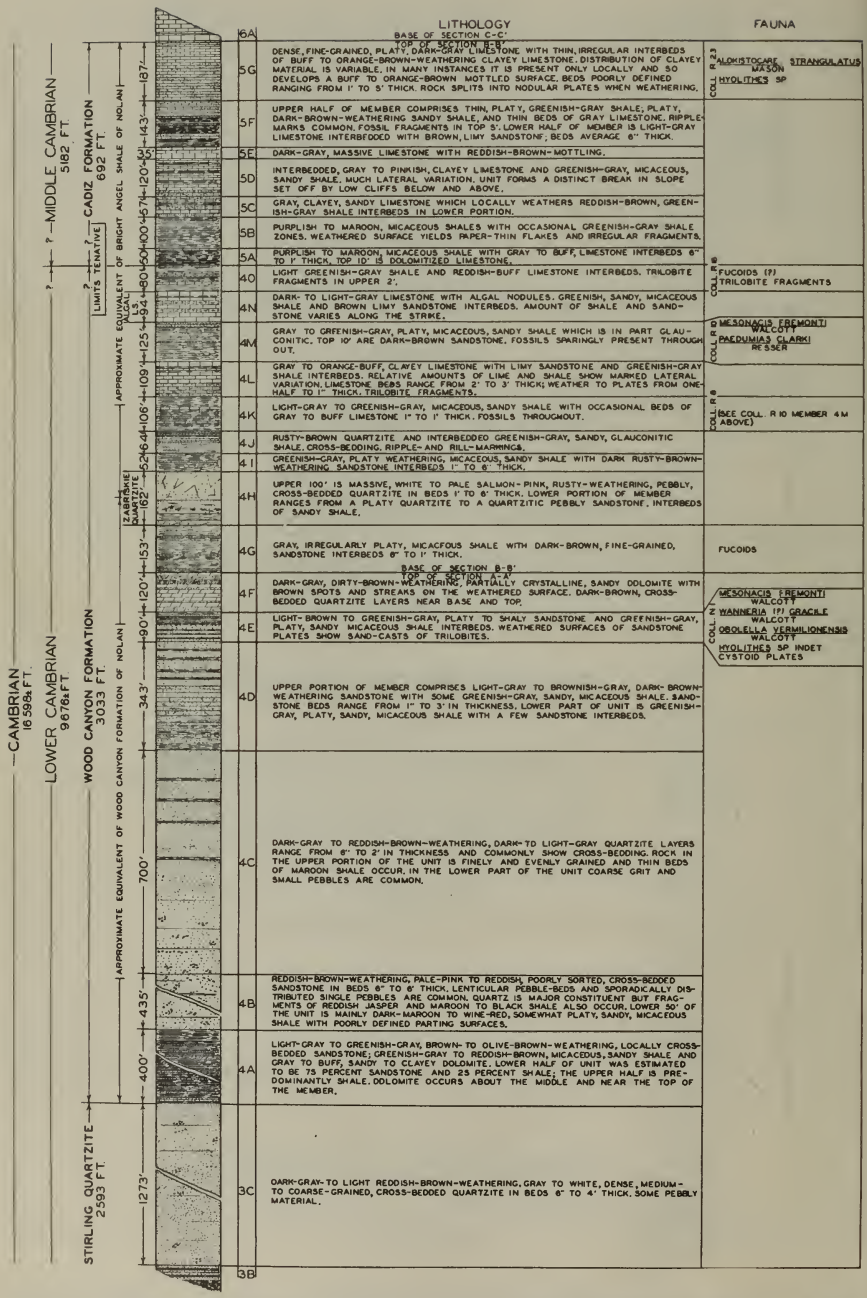

FIG. 3d. Columnar section of Paleozoic rocks of the Nopah-Resting Springs Mountains (Middle Cambrian, continued, and Lower Cambrian).

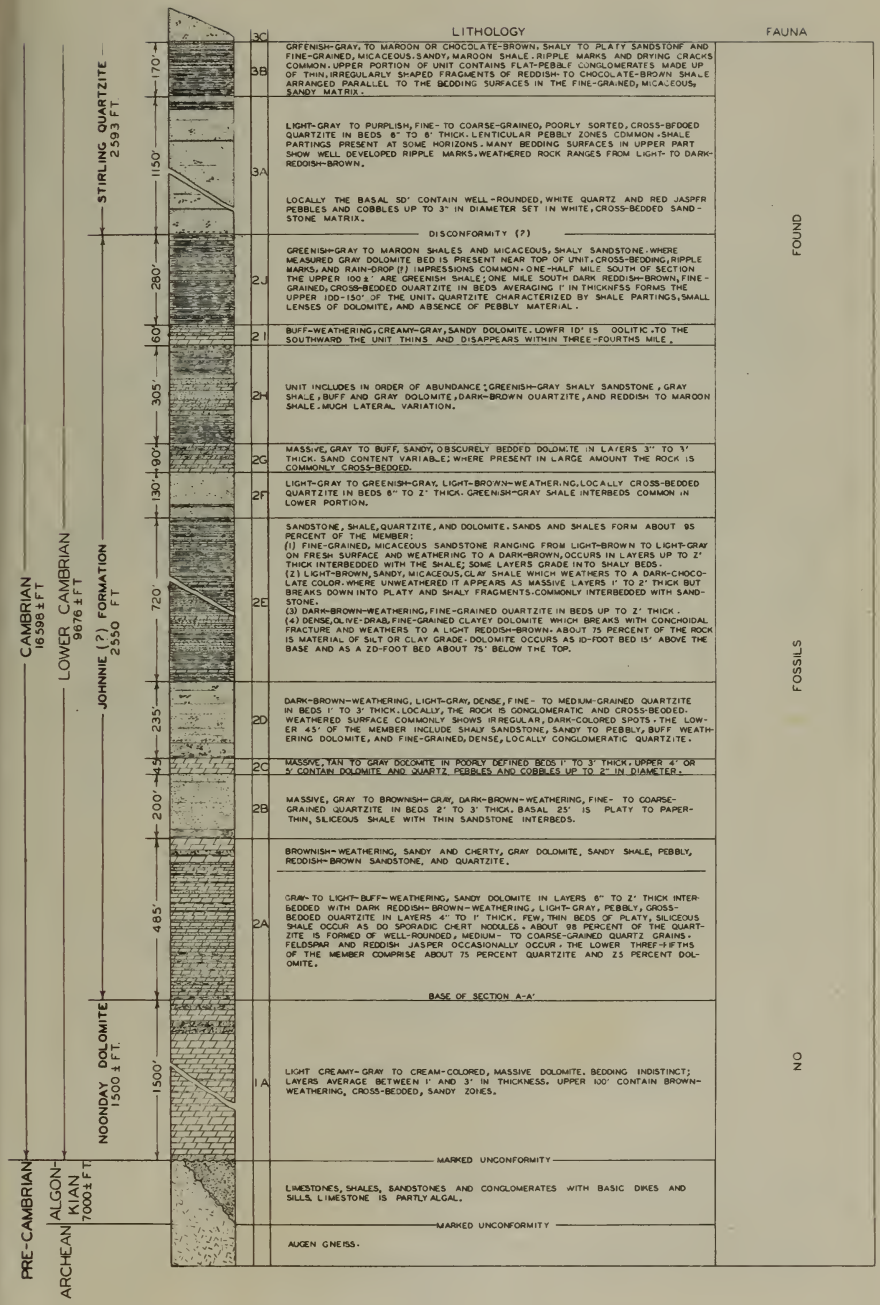

FIG. 3e. Columnar section of Paleozoic rocks of the Nopah-Resting Springs Mountains (Lower Cambrian, continued, and pre-Cambrian).

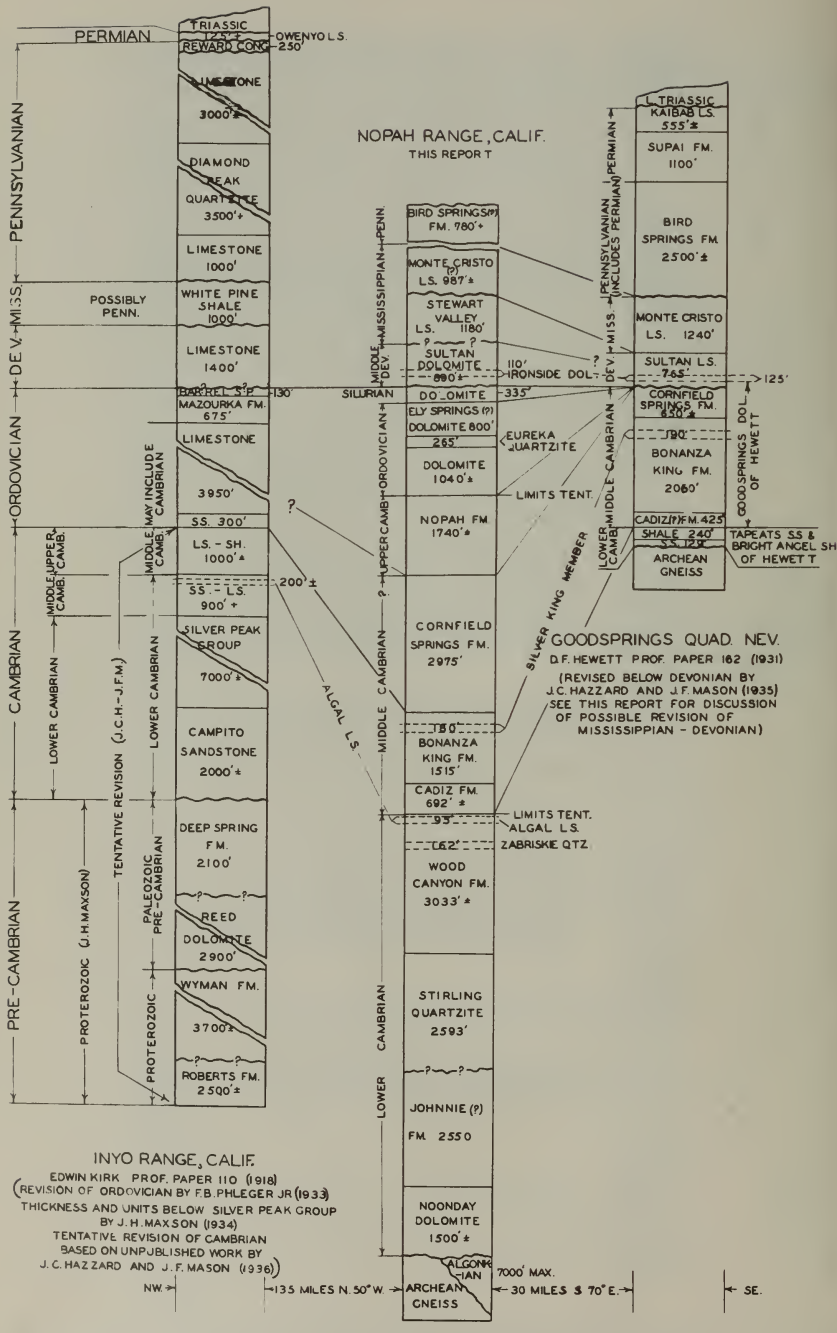

FIG. 4. Correlation of the Nopah-Resting Springs section with regions to the northwest and east.

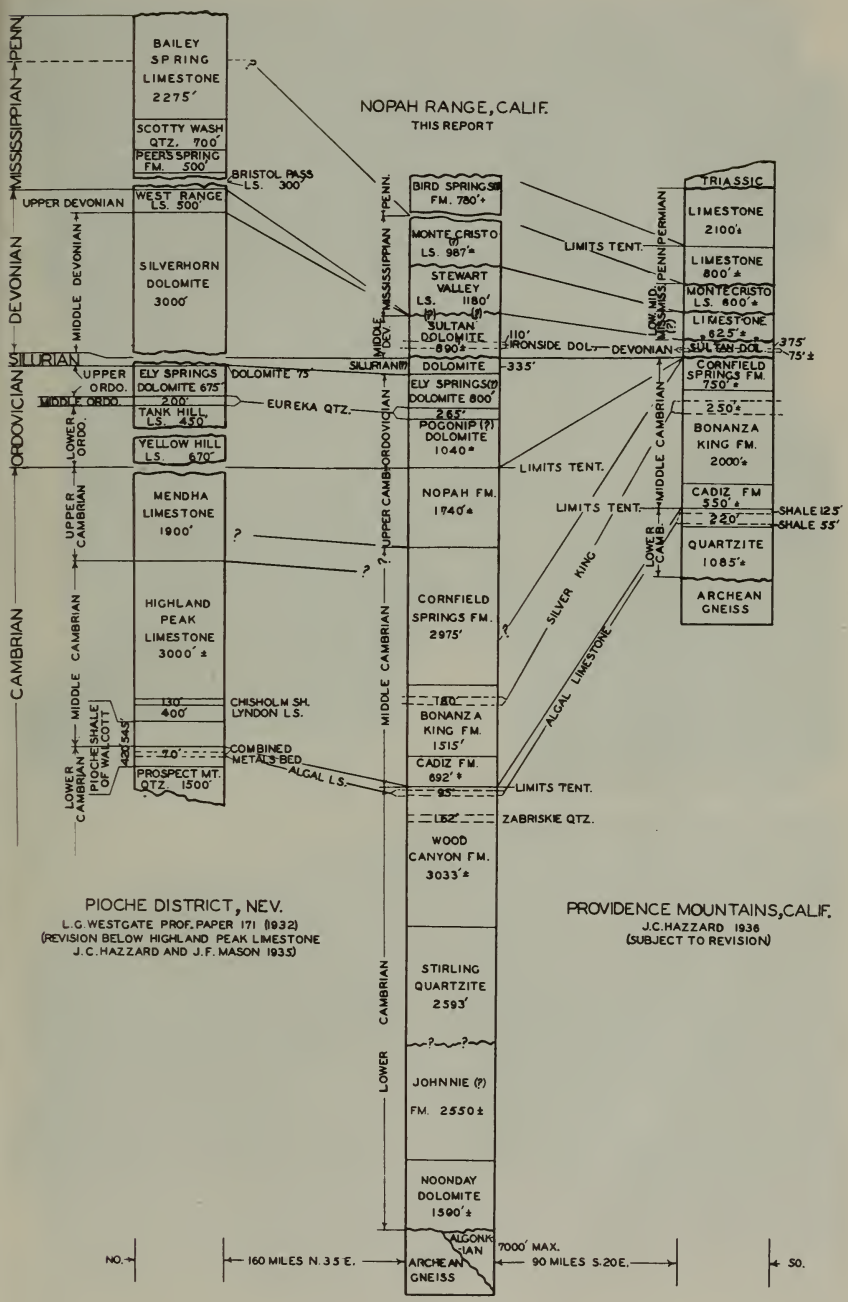

FIG. 5. Correlation of the Nopah-Resting Springs section with regions to the northeast and southeast.

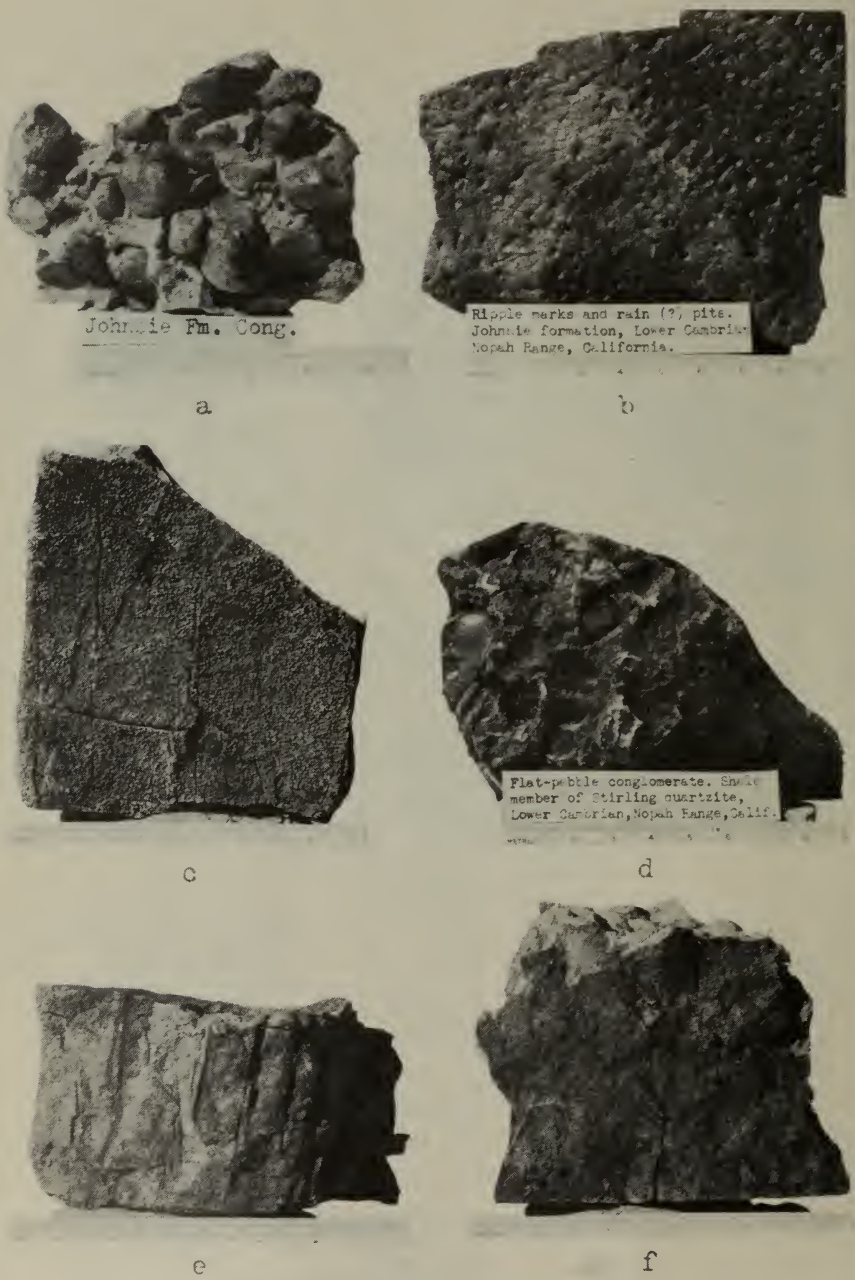

FIG. 6. Lithologic types from the Lower Cambrian beds of the Nopah-Resting Springs area. (a) Pebble-conglomerate with dolomite matrix from the top of member (2-C) of the Johnnie (?) formation. (b) Ripple-marked and rain (?)-pitted surface from maroon shale of member (2-J) of the Johnnie (?) formation. (c) Weathered surface of yellow-buff oölitic dolomite (member 2-I) of the Johnnie (?) formation. (d) Parting surface in flat-pebble conglomerate of member (3-B) of the Stirling quartzite. (e) Worm (?) burrows from the basal portion of the Zabriskie quartzite (member 4-H) of the Wood Canyon formation. (f) Same as (e); picture normal to bedding surface.

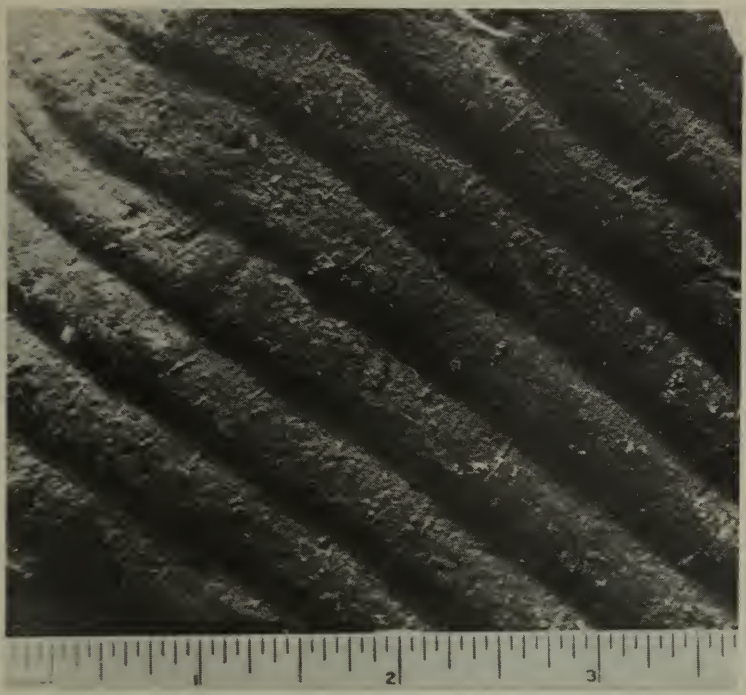

FIG. 7. Casts of ripple marks from base of member (3-B) of the Stirling quartzite (Lower Cambrian) in the southern portion of the Nopah Range.

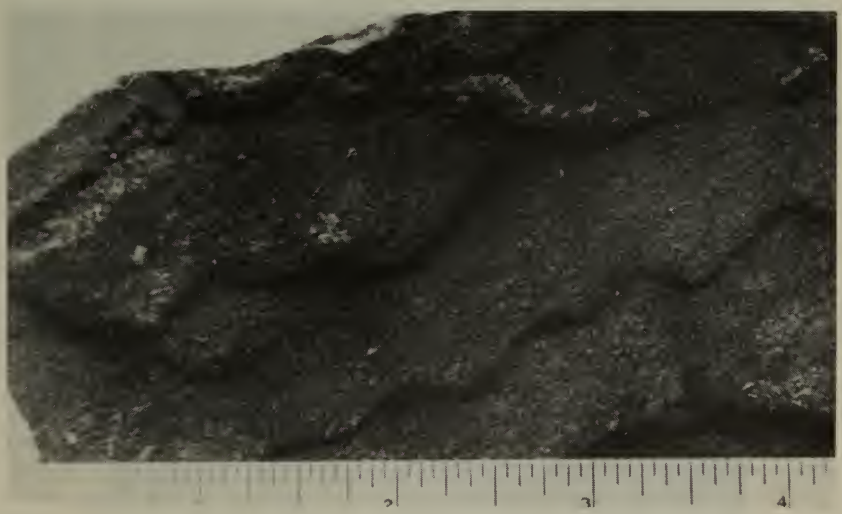

FIG. 8. Rill-markings from member (4-J) of the Wood Canyon formation (Lower Cambrian) in the southern portion of the Resting Springs Range.

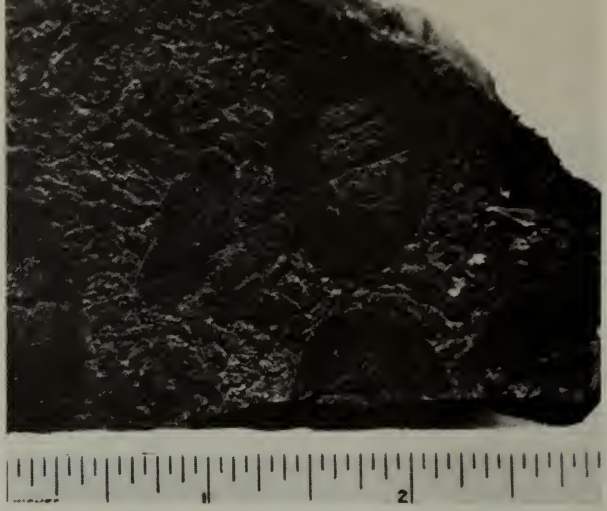

FIG. 9. Weathered surface of the "algal limestone" (member 4-N of the Lower Cambrian Wood Canyon formation) in the southern portion of the Resting Springs Range.

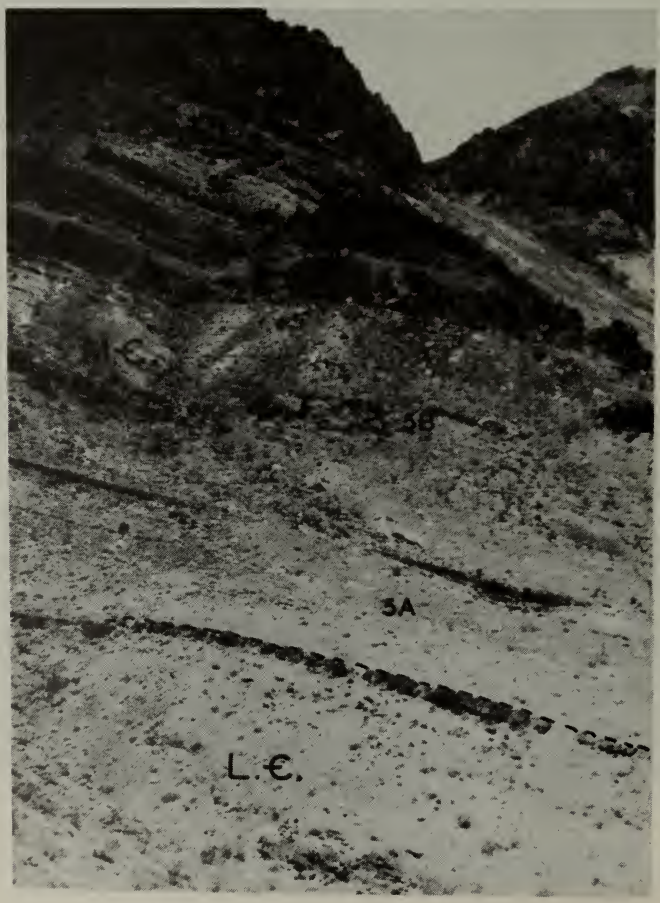

FIG. 10. Cadiz formation (Middle Cambrian) on the north side of Emigrant Pass, Nopah Range. Units are numbered to correspond with the columnar section. Beds strike N.35°W; dip averages 45° east. Dotted line indicates tentative upper limit of the Lower Cambrian (Wood Canyon formation).

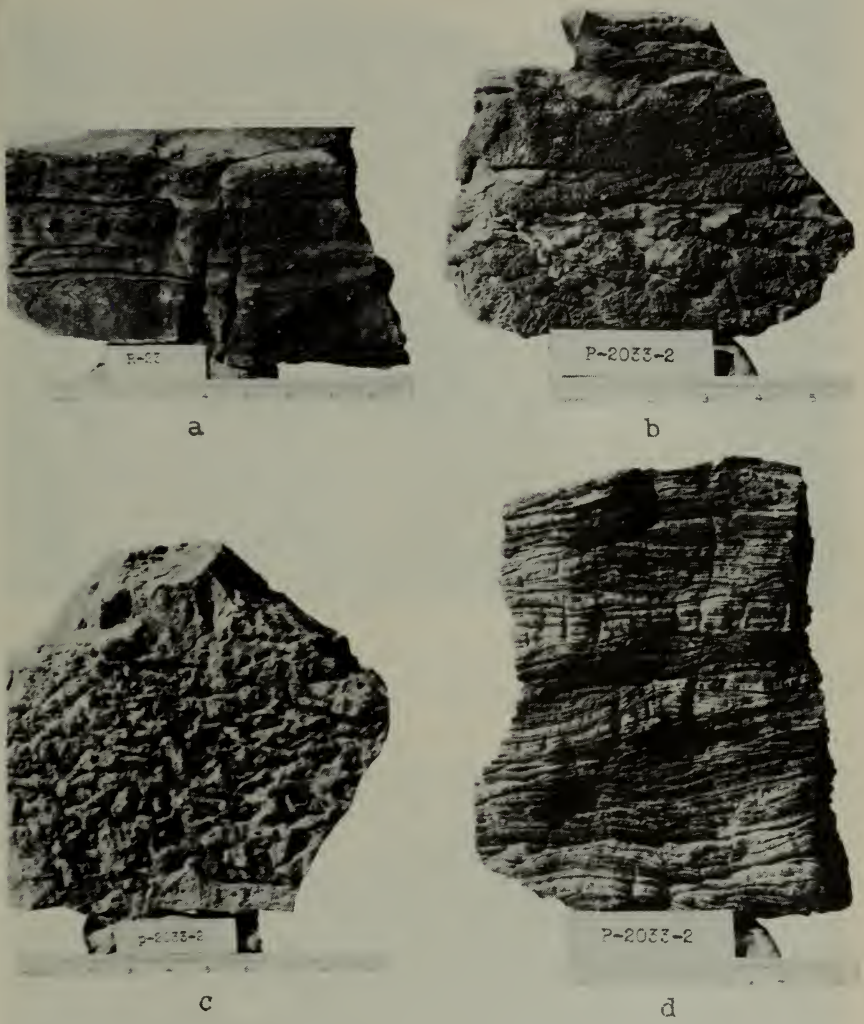

FIG. 11. Lithologic types from the Middle Cambrian beds of the Nopah-Resting Springs area. (a) Limestone from member (5-G) of the Cadiz formation. Rough-weathering bands are dark gray limestone; smooth-weathering bands are buff-colored, muddy limestone. (b and c) Partially dolomitized limestone from the Bonanza King formation. Darker-colored rougher weathering portion is dark-gray limestone; lighter colored areas are dolomite. (d) Same as (b and c). Dark-colored bands are limestone; lighter colored are dolomite.

FIG. 12. Basal member (7-A) of the Cornfield Springs formation (Middle Cambrian) and upper portion of the topmost member (6-E) of Bonanza King formation (Middle Cambrian). Photograph taken toward the north from fossil locality P.B. 7A on the western side of the Nopah Range.

FIG. 13. West side of the northern end of the Nopah Range. (1) Top-most portion of the Cornfield Springs formation (Middle Cambrian), (2) Nopah formation (Upper Cambrian), (3) Pogonip (?) dolomite (Lower Ordovician), (4) Eureka quartzite (Middle Ordovician), (5) Ely Springs (?) dolomite (Upper Ordovician), (6) Approximate position of the Silurian (?) beds, (7) Sultan dolomite (Middle (?) Devonian), (8) Stewart Valley limestone (Mississippian), (9) Monte Cristo (?) limestone (Mississippian), (10) Mouth of canyon in which faunal localities P.B. 8, 8A, and 9C are located. Section E-E′ was measured along the summit of the ridge on which numbers 1-4 are placed. Chicago Valley in the foreground.

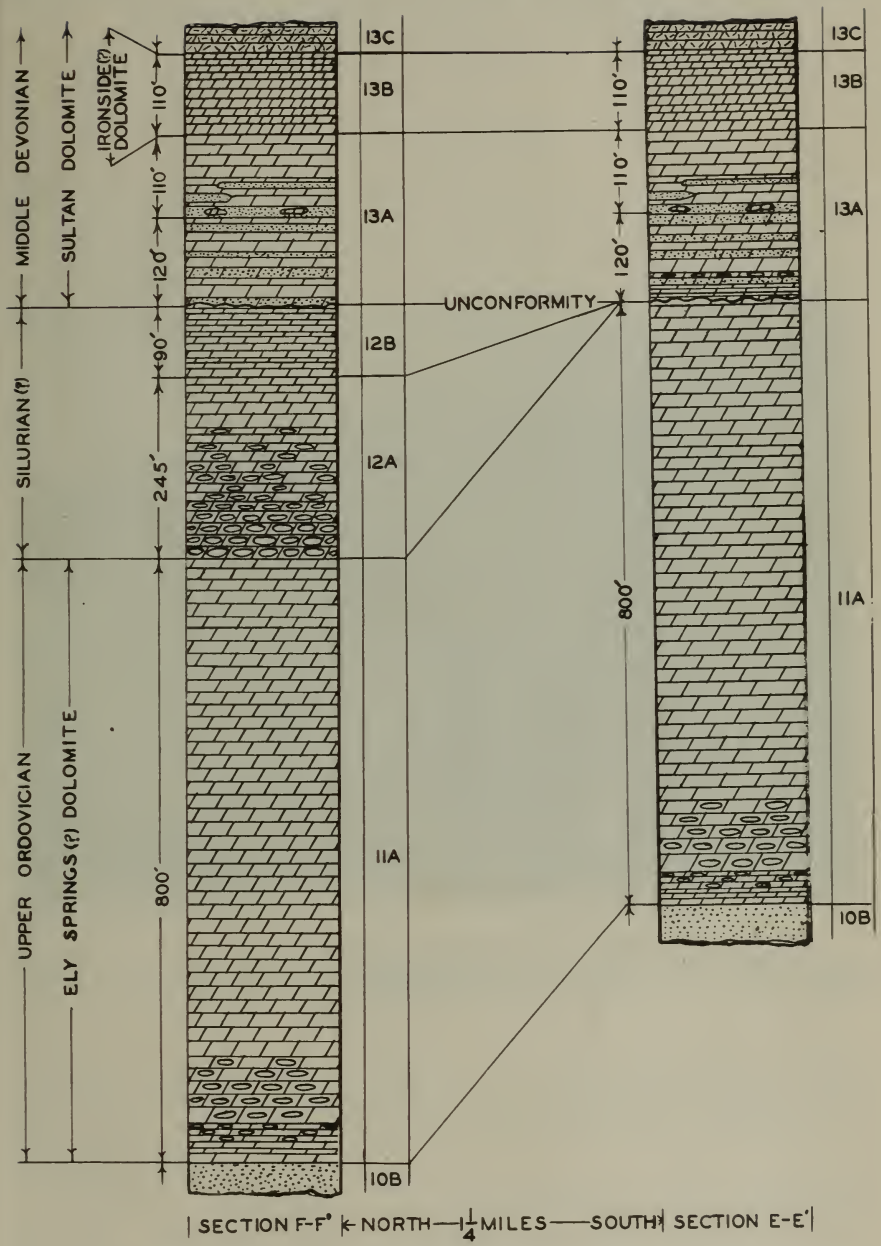

FIG. 14. Relations along the pre-Devonian unconformity in the northern portion of the Nopah Range.

Fig. 15. Bird Springs (?) formation (Pennsylvanian) on the eastern slope of the Nopah Range about 3½ miles south of the northern end. Beds strike N.50°W; dip averages 20° east. Section I-I′ was measured on the slope shown here. Mississippian section is overturned and thrust east over the Pennsylvanian.

PALEOZOIC SECTION IN THE NOPAH AND RESTING SPRINGS MOUNTAINS, INYO COUNTY, CALIFORNIA*

By John C. Hazzard**

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ABSTRACT

The Nopah and Resting Springs Mountains are located within the Furnace Creek and Avawatz Mountains quadrangles in southeastern Inyo County, California, approximately 40 miles east of the south end of Death Valley.

Eighteen formations of pre-Tertiary age have been recognized within the area. Of these, two are pre-Cambrian and sixteen are Paleozoic. The 22,875 feet of Paleozoic rocks are subdivided as fol-

* This paper has been accepted as a Ph.D. thesis by the Department of Geology, University of Southern California.

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lows: four formations of Lower Cambrian age totaling 9,676 feet; three Middle Cambrian formations 5,182 feet thick; one Upper Cambrian unit 1,740 feet thick, three Ordovician formations totaling 2,440 feet; one formation of Devonian age 890 feet in thickness; two Mississippian units the combined thickness of which is 2,167 feet; and one Pennsylvanian formation having a minimum thickness of 780 feet.

The Paleozoic section as summarized above is a composite of nine partial sections which were chosen in the field to show a reasonable overlap between stratigraphically adjacent portions. At no place in either the Nopah or Resting Springs Range is the complete Paleozoic section continuously exposed.

The Lower Cambrian rocks are especially notable for their great thickness and predominantly clastic nature. From the bottom up this series includes the following formations: (1) Noonday dolomite, 1,500 feet thick, (2) Johnnie (?) formations (quartzite, sandstone, shale, and dolomite), 2,550 feet thick, (3) Stirling quartzite, 2,593 feet in thickness and (4) Wood Canyon formation (quartzite, sandstone, greenish gray shales, and limestone), 3,033 in thickness. The names of the above enumerated formations, with the exception of the basal unit, are those which have been given to formational units of comparable character and age in the nearby Spring Mountans.

The lowest subdivision of the Middle Cambrian series is the Cadiz formation, 692 feet in thickness. This unit is predominantly clastic in nature and thus stands in marked contrast to the overlying Bonanza King and Cornfield Springs formations, 1,515, and 2,975 feet thick, respectively, which are made up almost exclusively of dolomite and dolomitic limestone. The three Middle Cambrian formations can be correlated on the basis of lithology and fauna with units of the same names in the region of the Goodsprings and Providence Mountains.

The Nopah formation, assigned to the Upper Cambrian is 1,740 feet in thickness. Except for the basal 100 feet which contains some clastic material, this unit is made up entirely of dolomite.

The rocks assigned to the Ordovician system include units ranging in age from Lower to Upper Ordovician. The lowest formation, termed the Pogonip (?) dolomite, comprises 1,040 feet of dolomite, in part sandy, clayey, and buff-weathering. Overlying these beds is a 265-foot unit of white, vitreous quartzite which is correlated with the Eureka quartzite, a well-known and widely distributed unit of the Ordovician system in the Great Basin region. Above the Eureka quartzite are 800 feet of dolomite which have been correlated tentatively with the Ely Springs dolomite of the Pioche, Nevada, area. Overlying the Ordovician, and present only locally in the northern portion of the Nopah Range, are 335 feet of light gray cherty dolomites which have been assigned tentatively to the Silurian.

The Devonian rocks, uncomformably overlying the Silurian and Ordovician, include 890 feet of dolomite and limestone. These beds have been grouped into one formation and correlated tentatively with the Sultan limestone of the Goodsprings, Nevada, region.

Two formations of Mississippian age are recognized. The basal unit, termed the Stewart Valley limestone, is 1180 feet in thickness. This is overlain uncomformably by 987 feet of beds tentatively correlated with the Monte Cristo limestone of the Goodsprings area. The

Pennsylvanian beds, 780 feet thick, are termed the Bird Springs (?) formation. Neither base nor top of this unit is exposed.

The Nopah-Resting Springs Paleozoic section should prove of value in developing a clear picture of conditions during the Paleozoic in the southern portion of the Great Basin region. Some of the most important features are summarized: (1) the marked thickness of the Lower Cambrian series; (2) the rather peculiar lithology of the Lower Cambrian series which is dolomitic at its base and almost entirely clastic above; (3) the great thickness of the Middle Cambrian rocks; (4) the occurrence of Upper Cambrian beds; (5) the presence of the Eureka quartzite; (6) the well-defined unconformity at the base of the Devonian; (7) the occurrence of the two Mississippian formations separated by an unconformity.

INTRODUCTION

Location and accessibility of the area

The Nopah and Resting Springs Mountains are located within the Furnace Creek and Avawatz Mountains quadrangles in southeastern Inyo County, California, approximately 40 miles east of the southern end of Death Valley (see figures 1 and 2). Examination of the map which accompanies J. E. Spurr's (Spurr, 1903: pl. 1, map)[1] report on the geology of Nevada south of the 40th parallel shows that prior to 1900 the mountains here termed the Nopah and Resting Springs Ranges were considered as parts of the Kingston Mountains. The map of the Furnace Creek quadrangle surveyed in 1905-1906 first used the term Nopah Range. The first published reference to the Resting Springs Range under its present name was made by Noble in 1926 (1926:65, and fig. 14, map).

The region is accessible by automobile from the village of Shoshone located about 2 miles west of the Resting Springs Range on the main highway (State Highway No. 127) from Baker, California, to Death Valley Junction. All the roads shown in the accompanying map (fig. 2) were passable in 1936 except the route from Resting Springs to Pahrump Valley through Emigrant Pass. The main road in the northern half of Chicago Valley has been relocated recently, and its present position is only approximately as shown on the map. No roads worthy of the name reach the west base of the Nopah Range, but an automobile can be driven some distance up the alluvial fan surfaces.

Water is available at Shoshone, Tecopa, Resting Springs, and Twelvemile Spring. Wells shown in Chicago Valley (fig. 2) were not examined, and the unnamed spring[2] northeast of Zabriskie at the western base of the Resting Springs Range was not visited.

Previous investigations

In common with much of southeastern California and southern Nevada, the Nopah and Resting Springs Ranges have received little attention from geologists. In 1903 Spurr (pp. 195-200) summarized the earlier work of R. B. Rowe, who in 1901 discovered Cambrian fossils in the hills about 2 miles north of Resting Springs and along the road through Emigrant Pass 4 to 5 miles[3] to the east. The faunal collections made by Rowe were later studied by Walcott (1912:185), and assigned U. S. National Museum locality numbers 14n, o, and p.

The only other important contribution to the knowledge of the pre-Tertiary rocks is that by Noble (1934). He referred to the Paleozoic

[1] See bibliographic list at end of paper.

[2] On Spurr's map (1903) this is termed Twelvemile Spring.

[3] Spurr (pp. 196-197) gives these figures, taken from Rowe's notes, as 7 and 8 miles respectively. Scaling distances on the present map would indicate that Rowe's fossil localities were in Pahrump Valley east of the Nopah Range. Such a conclusion is obviously incorrect and one must conclude that Rowe's estimates of distance were in error.

sequence in the Nopah and Resting Springs ranges in a general description of the rocks of the Death Valley region. Though Noble made no attempt to describe the rocks of these mountains specifically, practically all of his generalizations are in accord with the data obtained through the more comprehensive examination reported here. Rocks of Tertiary and Quaternary age have received somewhat greater attention because of their possible economic value (see Spurr, 1903:198-199; and Noble, 1922; 1926; and 1934). Ball's (1907) report on the geology of southwestern Nevada and eastern California does not mention the Nopah-Resting Spring area.

Present work

Reconnaissance for the U. S. Geological Survey during the years 1932 and 1933 indicated to Levi F. Noble the desirability of more detailed study among the Paleozoic rocks of the Nopah and Resting Springs Ranges. Dr. Noble suggested this investigation to the writer who at various times during 1934-36 collected the data upon which the present report is based. The writer wishes to express his appreciation to Dr. Noble for his interest and help in the field and for the many suggestions made during the preparation of this report; to Professors Thomas Clements, Arthur Tieje, and Malcolm Bissell, of the University of Southern California, for their helpful criticism and assistance; and to Mr. Walter W. Bradley and Dr. Olaf P. Jenkins of the California State Division of Mines for their aid in publication. William T. Roeseler and F. Maclin Carlisle served as field assistants. John F. Mason made many of the fossil collections and was helpful in the determination of the stratigraphy. The age references made in this report are based in part upon his faunal studies. Grateful acknowledgment of the post-Cambrian faunal determinations made by Dr. G. A. Cooper, U. S. National Museum, and Dr. Edwin Kirk, U. S. Geological Survey, is here made.

Field methods

At no place in either the Nopah or Resting Springs Ranges is there a continuous exposure of the complete section here described. As given, the section is a composite of nine partial sections chosen in the field to show a reasonable overlap between stratigraphically adjacent portions. Correlation between the partial sections was based upon distinctive lithologic characteristics and stratigraphic position. Thus in tying section A-A′ to section B-B′ a distinctive dolomite member (fig. 3d: unit 4-F) was used as a marker; in relating sections B-B′ and C-C′ the top of the Cadiz formation served as the common horizon.

The writer realizes that this method of correlation is open to criticism, but believes that no appreciable error was introduced in using it within the rather limited region wherein it was applied. Examination of several Paleozoic sections in southeastern California and southern Nevada has shown that many stratigraphic units retain their lithologic individuality over moderate areas and show little variation in thickness.

In the field the initial points for the various traverses were located by resection from [illegible] raphic features, and where possible, the lines [illegible] ship corners. All points were plotted

on plane-table sheets using a scale of 1 inch to 500 feet, and from the data obtained the thickness of the units was found by graphic methods. No areal mapping of more than reconnaissance nature was done.

The position of each section, as described in the following summary, is shown on the accompanying map (fig. 2).

Section A-A′.

Cambrian section is the southern end of the Nopah Range. The western, or basal, end of the traverse is approximately a quarter of a mile east of the end of the road to a small prospect hole 1 mile N. 22 E. of the Gunsight mine, which is 5½ miles east of the town of Tecopa.[4] The base of the section was taken approximately on the 2,500-foot contour at the top of the light buff-colored dolomite (Noonday dolomite). The eastern end or summit of the traverse, is immediately west of summit 4,215, 2 miles east of the mine. The line of section bears S. 73° E. and is approximately 2 miles in length. Average strike of beds is N. 15° W. The dip ranges from 35° to 60° east. Thickness of beds here measured is 7,231 feet.

Section B-B′.

Cambrian section on the western slope of the Resting Springs Range near its southern end. Section was measured in two units of about equal length and half a mile apart. The southernmost unit is about 1 mile north of the fossil locality reported by Rowe (Spurr, 1903:196) and 2¾ miles north of Resting Springs. The western or basal end of the traverse was taken approximately on the 1,900-foot contour line at a point roughly 4¾ miles N. 77° E. of Zabriskie station on the Tonopah and Tidewater Railroad. The line of section bears N. 65° E. and is about half a mile long. The upper half of the section was offset half a mile northward so that it could be extended to the top of the Cadiz formation. Average strike of beds is between N. 20° E. and N. 25° E. The dip is usually between 50° and 60° east. Thickness of beds here measured is 1,637 feet.

Section C-C′.

Cambrian section in the central portion of the western front of the Nopah Range. The western or basal end of the traverse is about 5½ miles N. 85° E. of the summit of the pass across the Resting Springs Range followed by the Shoshone-Pahrump road. The base of the section was taken approximately on the 3,000-foot contour at the base of a massive-bedded, dark-gray limestone (Bonanza King formation). The eastern end or summit of the traverse, is very near the 4,000-foot contour line. The line of section, which falls almost exactly along the 36th parallel, bears N. 85° E., and is approximately one-quarter of a mile in length. Average strike of beds is between N. 5° W. and N. 10° W. The dip is usually between 20° and 25° east. Thickness of beds here measured is 1,240 feet.

Section D-D′.

Cambrian section in the central portion of the western front of the Nopah Range. The western or basal end of the traverse is about 3 miles S. 62° E. of Twelvemile Spring. The base of the section was taken approximately on the 3,200-foot contour at the top of the dark smoky-gray Silver King (?) member of the Bonanza King formation. The eastern end or summit of the traverse is very near the 4,000-foot contour line. The line of section, which is 1 mile north and nearly parallel to that of section C-C′, bears N. 87° E. and is approximately half a mile in length. Average strike of beds is N. 20° W. The dip is usually between 30° and 35° east. Thickness of beds here measured is 1,815 feet.

Section E-E′.

Cambrian-Ordovician section on the northwestern slope of the Nopah Range. The western or basal end of the section is about 4¾ miles due north of Twelvemile Spring. A very poorly defined road branches to the east off the old road through Chicago Valley about 3½ miles north of Twelvemile Spring (position of the new graded road now in use is not shown on the Furnace Creek topographic sheet) and ends about half a mile south of the west end of the section. The base of the section was taken approximately on the 3,000-foot contour line at the top of a somewhat massive, dark smoky-gray limestone which crops out at the west base of a low, westward-extending spur. The eastern end or summit of the traverse, is about on the 4,700-foot contour line, at the base of the Eureka quartzite. The line of section bears N. 40° E. and is approximately a mile in length. Average strike of the beds is between N. 50° W. and N. 60° W. The dip ranges from 40° to 60° east, increasing toward the upper or eastern end of the section. Thickness of beds here measured is 4,215 feet.

Section F-F′.

Ordovician-Devonian section on the western slope of the Nopah Range near its northern end. The western or basal end of the section is about 6 miles N. 8° W.

[4] The town of Tecopa here referred to is the [illegible] map wo[illegible] on the Avawatz Mountains topographic sheet; this is not the same [illegible] the Nopah R[illegible] mentioned by Spurr, which is about 7½ miles southeast of the prese[illegible]ude that Rowe's estimates of the old Tecopa smelter (see fig. 2).

of Twelvemile Spring and is just west of the line between Rs. 7 and 8 E., T. 23 N. The base of the section was taken on about the 3,200-foot contour line at the base of the Eureka quartzite. The eastern end or summit of the traverse is a few hundred feet west of summit 4,500 which shows on the topographic map west of the "N" in the word "Nopah" (Furnace Creek quadrangle). The line of section bears N. 63° E. and is approximately half a mile in length. Average strike of the beds is N. 50° W. The dip ranges from 25° to 40° east. Thickness of beds here measured is 2,150 feet.

Section G-G′.

Devonian—Mississippian section on the eastern slope of the Nopah Range about 5 miles south of the northern end. The southern, or basal end of the traverse, is about 2 miles west of the old traction road at an elevation of approximately 3,300 feet. The traverse crosses a northeasterly extending spur, and the northern end or summit is at an elevation of about 3,600 feet.[5] The line of section trends approximately due north and is about a mile in length. Average strike of the beds is N. 55° W. The dip ranges from 20° to 30° northeast. Thickness of beds here measured is 1,835 feet.

Section H-H′.

Mississippian section on the eastern slope of the Nopah Range about 4 miles south of the northern end. The western or basal end of the traverse is about three-quarters of a mile west of the top of section G-G′ at an elevation of approximately 3,700 feet. The section was taken on the east side of a short, northward-trending canyon which can not be seen from the east front of the range. The eastern end or summit of the traverse is approximately 400 feet higher than the western end. The line of section trends S. 73° E. and is about 500 feet in length. Average strike of the beds is N. 65° W; dip averages 25° northeast. Thickness of beds here measured 475± 25 feet.

Section I-I′.

Pennsylvanian section on the eastern slope of the Nopah Range between 3 and 3½ miles south of the northern end. The line of traverse was taken on the north side of the first large eastward trending canyon south of the north end of the range (see fig. 13). The southern or basal end of the section is approximately on the 3,300-foot contour; the northern end or summit about 300 feet higher. The line of section trends north and is about 1,000 feet long. Average strike of the beds is N. 50° W; dip averages 20° northeast. Thickness of beds here measured is 780+ feet.

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[5] The outline of the Nopah Range as shown on the Furnace Creek quadrangle is very generalized. Thus the line of section here described, and those which follow, do not appear to match the topography.

GENERAL GEOLOGY

General stratigraphy

The stratigraphic sequence presented in this paper is somewhat generalized. Some of the systems and series of rocks can not as yet be precisely delimited, and it must be emphasized that in such cases the limits here given are only tentative. Further, detailed work is necessary before exact correlation can be made with sections in adjoining regions. Formational and member names already in use in surrounding areas have been adopted whenever the faunal and lithologic evidence has been deemed sufficient.

Eighteen pre-Tertiary formations have been recognized in the Nopah-Resting Springs area. Of these, two are of pre-Cambrian age and sixteen are Paleozoic. The 22,875+ feet of Paleozoic rocks are subdivided as follows: four formations of Lower Cambian age totaling 9,676± feet; three Middle Cambrian formations 5,182 feet thick; one Upper Cambrian unit 1,740 feet thick; three Ordovician formations totaling 2,105 feet; one unit of Silurian (?) age 335 feet thick; one Devonian formation 890 feet in thickness; two Mississippian units totaling 2,167+ feet thick; and one formation of Pennsylvanian age having a minimum thickness of 780 feet. This section is summarized in the following table:

TABLE 1. PALEOZOIC AND PRE-CAMBRIAN FORMATIONS OF THE NOPAH AND RESTING SPRINGS MOUNTAINS

PALEOZOIC:			
Pennsylvanian			780+ feet
Bird Springs (?) formation	780+		
Mississippian			2,167+
Monte Cristo (?) limestone	987+		
UNCONFORMITY			
Stewart Valley limestone	1,180+		
UNCONFORMITY (?)			
Devonian			890
Middle (?) Devonian			
Sultan dolomite	890		
UNCONFORMITY			
Silurian (?)			335
Ordovician			2,105
Upper Ordovician			
Ely Springs (?) dolomite	800		
Middle Ordovician			
Eureka quartzite	265		
Lower Ordovician			
Pogonip (?) dolomite	1,040		
Cambrian			16,598±
Upper Cambrian		1,740	
Nopah formation	1,740		
Middle Cambrian		5,182	
Cornfield Springs formation	2,975		
Bonanza King formation	1,515		
Cadiz formation	692		
Lower Cambrian		9,676±	
Wood Canyon formation	3,033		
Stirling quartzite	2,593		

DISCONFORMITY (?)

Johnnie (?) formation	2,550	
Noonday dolomite	1,500±	
Total thickness of Paleozoic		22,875+

UNCONFORMITY

PRE-CAMBRIAN:		
Algonkian		7,000 (max.)

UNCONFORMITY

Archean	Granite gneiss.

The structural factor in regional correlation of the Nopah-Resting Springs area

In attempting to correlate the post-Archean rocks of the Nopah-Resting Springs section with those exposed in adjoining areas, present geographic relations must be evaluated with respect to known structural conditions. Such an evaluation is absolutely necessary in order to eventually develop a reasonable conception of the limits of the Algonkian and Paleozoic basins of deposition and an understanding of the conditions of sedimentation which existed therein.

Detailed structural studies in the Spring Mountains, which are parallel with and about 15 miles east of the Nopah Mountains, and in the ranges north and northwest of Las Vegas, Nevada, by Longwell (1926), Hewett (1928 and 1931), Nolan (1929) and Glock (1929) have shown the presence of both low and high-angle thrust faults of great horizontal displacement. Hewett (1928) has described a great thrust fault (Shadow Mountain thrust), which is well exposed 30 to 35 miles southeast of the Nopah-Resting Springs area, along which thrust he suggests an eastward movement of at least 10 miles.

The presence of thrust faults of comparable displacement in the Nopah and Resting Springs Ranges has not as yet been demonstrated, but Noble (oral communication, 1935) has found extensive thrusting in closely adjoining regions and some thrusting is known to have occurred in the extreme northern portion of the Nopah Range. The probability that the rocks of the Nopah and Resting Springs Mountains have been thrust eastward some distance from their original place of deposition must be kept in mind. If such is the case, correlation from known autochthonous beds to rocks of the thrust sheet must be done cautiously.

As a part of a northwesterly belt, the Nopah-Resting Springs area lies between the Goodsprings region (Hewett, 1931), roughly 30 miles to the east, and the Inyo Mountains (Knopf, 1918), about 135 miles to the northwest. The Paleozoic sections in both these areas have been described in some detail. In a meridional direction, the best known sections for comparison are (1) in the Providence Mountains about 75 miles to the southeast, (2) in the northwest portion of Spring Mountain (Nolan, 1929) 25 miles to the northeast, and (3) in the Pioche District (Westgate, 1932), roughly 165 miles northeast. Tentative correlation of the Nopah-Resting Springs section with the rocks of all of these areas except the northwest portion of Spring Mountain, is outlined in figs. 4 and 5.

Economic possibilities of the Paleozoic rocks

Practically all the mineral production so far obtained from the Paleozoic rocks of the Nopah-Resting Springs area has come from the

Gunsight, Noonday, and Grant mines (Tucker, 1921:286-287 and 291-293) in the southern end of the Nopah Range. A minor amount of prospecting has been done at various places along the western front of the Nopahs, principally toward the northern end. To date nothing of value has been discovered. The northern 3 to 4 miles of the range should offer good possibilities, however, for in that area the Devonian and later rocks have been altered locally to marble and extensive faulting has occurred. In the Paleozoic rocks of the Resting Springs Range only two prospects are known near Shoshone. The Redwing mine, 4 miles northeast of Shoshone is in dolomite of the Bonanza King formation. The Baxter mine some miles to the north probably is in the same formation.

The Gunsight, Noonday, and Grant mines produce from mineralized fissures in the Noonday dolomite (Lower Cambrian). So far as is known no production has been obtained from either the Archean and Algonkian rocks below or from the Johnnie (?) formation (Lower Cambrian) above. Mineralization of the dolomite is not only characteristic of the Nopah area but is known at other localities. The Silver Rule mine (Tucker, 1921:365-366), several miles east of the Noonday mine in the northern end of the Kingston Range, is in this same formation. Noble reports (oral communication) that in the Death Valley region prospect holes are common in practically all outcrops of the Noonday and that many of the openings show evidence of mineralization of the dolomite.

From the above data it appears that the Noonday dolomite shows evidence of mineralization over a wide area and that the mineralization has been selective in a general way; the dolomite being more extensively mineralized than the rocks below or above. Such a relation suggests strongly that some property of the rock itself has been a controlling factor. Either the chemical character of the dolomite, or its physical properties, or both, have been operative. The dolomite is a brittle, massive rock with poorly defined bedding. Compared with the rocks below and above it offers a greater chance for the development of extensive breccia zones when faulted. Such a feature, in addition, perhaps, to the chemical character of the rock, may have been important in controlling the mineralization. In the opinion of the writer a careful study of the fault system in the Gunsight-Noonday area might result in the development of new orebodies. Careful prospecting of the Noonday dolomite wherever found would also be worth while.

THE GEOLOGIC FORMATIONS

PRE-CAMBRIAN ROCKS

Pre-Cambrian rocks crop out in the extreme southern end of the Nopah Range south of a line through the Gunsight mine and Tule Holes (see fig. 2). The unconformity at the base of the Cambrian is well exposed at the Gunsight mine and the contact can be traced in a southerly direction to, and beyond the Noonday mine. At Gunsight the Cambrian rests on Archean rocks; near the Noonday mine Algonkian strata lie beneath the unconformity.

The Archean at the Gunsight mine is a dark-colored biotite-granite gneiss, characterized by porphyroblasts of pinkish feldspar. This is a common rock type in the Archean complex. Noble (1934:173) describes the Archean rocks of the Death Valley regions as follows:

> "They are chiefly gneisses and mica schists but include bodies of quartzite and limestone. A common type of gneiss is remarkably coarse and granitic and contains conspicuous large crystals of pink feldspar. Another common type is a dark-gray dioritic gneiss or mediorite. All the Archean rocks have been recrystallized by heat and pressure and contain no recognizable traces of life. In origin they are in part igneous and in part sedimentary. As a whole they greatly resemble the Archean rocks that make the Granite Gorge in the bottom of the Grand Canyon."

The Algonkian strata which are present beneath the Cambrian in the Noonday mine are chiefly shales and conglomeratic sandstones. Noble (1934:174) has described these Algonkian rocks in the Death Valley area as

> "* * * series of limestones, shales, sandstones and conglomerates which at many places contain bodies of a dark basic igneous rock that was injected into them as sills and dikes in pre-Cambrian time. The thickness of the series may be as much as 17,000 feet, although no complete section is exposed at any one locality."

CAMBRIAN SYSTEM

General distribution of the rocks

The geologic map which accompanies Spurr's report (1903:pl. 1, map) shows the rocks of the Nopah and Resting Springs Ranges mapped as Cambrian, with the exception of a small area in the southern portion of the Nopah Mountains assigned to the Jurassic. On the Geological Map of California (Smith, 1916) the rocks of the Nopah Range are also assigned to the Cambrian, but the southern half of the Resting Springs Range, from a few miles north of Shoshone, is mapped as Silurian.

Cambrian rocks are present over almost the entire length of the Nopah Mountains. South of summit 6,415 (see fig. 2) they are of Middle Cambrian age; to the north higher Cambrian beds and Lower and post-Cambrian Paleozoic formations occur high on the west-ern front of the mountains about 4 miles north of summit 6,415; north-ward they occupy large portions of the mountain area and are increas-ingly present on the lower west slopes. Approximately 4 miles south of the northern end of the range Cambrian rocks no longer appear.

crop out on the west front, and rocks of Ordovician, Silurian (?), Devonian, and Mississippian age form the whole range slope. Pennsylvanian beds occur over a very limited area on the northeast side of the mountains 3 to 3½ miles south of the northern end. The extreme northern tip of the mountain ridge is made up of Lower Cambrian quartzite thrust over younger Paleozoic beds.

The Resting Springs Range, for about 20 miles north of Resting Springs, is made up almost entirely of Cambrian rocks. Small areas of Tertiary volcanic material are present along the west flank of the mountains north of the Shoshone-Pahrump road and along the east flank north and south of the road.

Noonday dolomite (Lower Cambrian)

Distribution: The Noonday dolomite is the basal Cambrian formation in the region. It is the undoubted equivalent of the dolomite studied by Dr. D. F. Hewett of the U. S. Geological Survey (Noble, 1934:175 and note 7) in the vicinity of the Silver Rule mine on the northwest slope of the Kingston Mountains, about 6 miles southeast of the Nopah Range. Noble has found this same formation near Jubilee Pass, west of Shoshone; on the east slope of the Panamint Range, opposite the south end of Death Valley; and along the Shoshone-Baker highway near its crossing of the Amargosa River south of the Inyo-San Bernardino County line (Noble, 1934:177, and oral communication).

In the Nopah-Resting Springs area the dolomite is well exposed in the extreme southern portion of the Nopah Range cropping out in a belt of variable width which extends from about 1 miles north of the Gunsight mine to nearly 2 miles southeast of the Noonday mine. Along the mountain base at the Gunsight mine, and for some distance both northwest and southeast, this formation develops a bold, more or less cliff-like escarpment which can be distinguished readily from a distance. Noble (1934:175) states that,

> "The thick bed of limestone [dolomite] at the base of the Lower Cambrian is for stratigraphic purposes one of the most important rocks in the pale buff color and the massive character of the bed render it conspicuous. The great distances, so that it serves as a marker to guide the observer to pass from the Paleozoic and the unconformity between the Paleozoic and the base of Archean and Algonkian."

Lithology: No detailed study of the Noonday dolomite was made, as this formation will be more carefully treated (possibly under a different name) in Hewett's forthcoming report on the geology of the Ivanpah quadrangle, and in further publications of Noble on the Death Valley area.

In general, the rock is a light creamy-gray to cream-colored algal dolomite which weathers to a pale creamy-buff color. As a rule, individual layers are indistinct. The upper portion is sandy and at some places contains coarse grit and fine gravel composed of well-rounded to subangular fragments of white quartz and reddish jasper. The sandy and gritty portions usually weather to a rusty-brown color and at many places show cross-bedding.

Thickness: At the Silver Rule mine locality Hewett reports (Noble, 1934:175) that the formation is 2,000 feet thick. The 1,[illegible]0± feet here reported from the Gunsight mine area is an estimate for there

Joh omite is involved in thrusting of unknown magnitude and is y normal faults so that an accurate measurement of the thick- comp d not be obtained.

Age and correlation: No fossils, other than algae, were found in the Noonday dolomite. It is here assigned to the Lower Cambrian because of (1) its separation by marked angular unconformity from the rocks of Archean and Algonkian age below, and (2) because of its position at the base of a possibly unbroken sedimentary sequence which, from fossils obtained in the upper portion, is known to be Lower Cambrian in age. The name is taken from the Noonday mine, a mile southeast of the Gunsight mine.

Hewett has shown (Noble, 1934:175) that east and south of the Silver Rule mine the formation thins rapidly; east of the Goodsprings quadrangle where the base of the Paleozoic is exposed near Jean, Nevada, the Noonday dolomite does not occur. To the south, in the Providence Mountains, the base of the Cambrian is marked by a 50- to 100-foot zone of dolomite which, however, on the basis of data now available, can not be correlated with the Noonday dolomite. The formation is not known to occur north of Furnace Creek in the Death Valley area (Noble, 1934:175).

In the Cambrian and pre-Cambrian of western Nevada and eastern California, thick dolomitic units below the lowest fossiliferous Cambrian beds have been described in two areas. In the Inyo and White Mountains, Kirk (Knopf, 1918:24; see also Maxson, 1934, and Anderson, 1937) found a thick dolomite (Reed dolomite) beneath the lowest Cambrian sandstone (Campito sandstone). This he assigned to the pre-Cambrian. Spurr (1906:18) states that in the northwestern portion of the Silver Peak quadrangle, Nevada, there are "several thousand feet of dolomitic limestone and marble, quartzite, and green knotted schists." These he refers to the Cambrian. Turner (1909:238), in speaking of the same beds suggests a possible pre-Cambrian age though he says "it is quite possible that they represent the base of the Cambrian."

It is likely that the sections described by Spurr and Turner are correlative, in a general way, with the Lower Cambrian section measured by F. B. Weeks (Walcott, 1908:188-189) near Barrel Spring, 16 miles south of Silver Peak, Nevada, where thick limestones, some containing Archaeocyathinae, occur near the base of the exposed section. Lithologically, these rocks resemble neither the Noonday dolomite nor the Reed dolomite. In the opinion of the writer, based upon the reports of Kirk (Knopf, 1918) and Walcott (1908), as well as upon examination of the Barrel Spring, Inyo and White Mountains sections, the coralline limestones belong some distance stratigraphically above the Reed dolomite.

No definite correlation is made here between the Reed and Noonday dolomites, but a question naturally arises as to whether the dolomite of the Inyo and White Mountains is correctly placed stratigraphically, or conversely, whether the Noonday dolomite is correctly assigned to the Lower Cambrian. It is not possible to discuss this rather perplexing problem at present, but field work is now in progress which, it is hoped, will yield an answer to this question. For the sake of comparison, chemical analyses of both Noonday and Reed dolomites are given herewith.

TABLE 2. COMPARATIVE ANALYSES OF THE NOONDAY AND REED DOLOMITES*

Source	SiO_2	CaO	MgO	Fe_2O_3	Al_2O_3	TiO_2	P_2O_5	MnO	H_2O	Loss on ignition	Total	Calculated composition	
												$CaCO_3$	$Ca,MgCO_3$
(1) Noonday Dolomite from near Gunsight Mine, Nopah Mts., Inyo County, Cal.	.31	30.73	20.90	1.44	.29	Trace	.09	.05	.07	45.90	99.78	2.964	95.584
(2) Reed Dolomite from head of Wyman Creek, White Mts., Inyo County, Cal.	1.46	30.19	20.34	1.63	.37	.08	.09	.12	.09	45.72	100.09	3.391	93.022

*Analyzed by A. H. Phillips, 1936. Insoluble .48% and 1.36% respectively, K_2O and Na_2O not determined.

Johnnie (?) formation (Lower Cambrian)

Distribution: Rocks which are stratigraphically and lithologically comparable to the Johnnie formation of Nolan (1929:461-463) are well exposed in the southern end of the Nopah Range 1 mile east of the Gunsight Mine. There they form a northwest trending belt lying between the massive, cliff-forming Noonday dolomite on the west and the high prominent ridge produced by the resistant Stirling quartzite to the east. Though this belt of rock is interrupted by cross-faulting, it is continuously traceable from southeast of the Noonday mine to a point approximately 1½ miles north of the Gunsight mine, where it passes under the alluvium in the southern end of Chicago Valley. The upper portion of the formation crops out 2 to 3 miles north of Emigrant Pass on the lower western slopes of the Nopah Range. Noble reports (written communication, 1936) the presence of the Johnnie (?) formation in the Death Valley slope of the Panamint Range.

Lithology: Where examined north of the Gunsight mine the lower 485 feet of the Johnnie (?) formation is composed chiefly of interbedded quartzite and sandy dolomite. In a sense, this portion of the formation is a transitional zone between the nearly pure carbonate rocks in the Noonday dolomite below and the predominantly clastic rocks above. The upper 290 feet of the member includes light-gray to buff, partially sandy dolomite in layers 6 inches to 35 feet thick; reddish-brown-weathering pebbly sandstone and quartzite; and reddish-brown siliceous paper-thin shales. Much of the dolomite is very fine-grained and breaks with a conchoidal fracture. The amount of quartz sand admixture is estimated to range from 20 to 60 per cent; the finest fragments are angular, the coarser grains are well-rounded and some are large enough to be classed as fine gravel.

The sandstones and quartzites, which occur in beds up to 20 feet in thickness, range from medium- to very coarse-grained and are in part poorly sorted. Material of gravel grade occurs in many of the beds; the maximum sized pebble observed was between a quarter and half an inch in diameter. Quartz is the major constituent but fragments of fine-grained black quartzite, reddish jasper, and feldspar occur sporadically. The major portion of the cementing material is silica but calcareous cement occurs locally.

The lower 195 feet of the member is about 70 per cent quartzite and 30 per cent dolomite in alternating layers ranging from 6 inches to a foot thick. These percentages vary along the strike as do the thickness and continuity of the individual beds. The quartzite is light-gray to light yellow-brown on a fresh break but weathers to a dark reddish-brown color. Many individual layers show local cross-bedding. Well-rounded, medium to coarse quartz grains comprise 98 per cent of the rock b[illegible] feldspar and reddish jasper fragments occur occasionally. [illegible] and gritty lenses are not uncommon. The cementing [illegible] siliceous but small amounts of both lime and iron [illegible] The dolomite is gray to buff in color and normally [illegible] lish-brown. Where sandy it takes on a dark-brown [illegible] e quartzite and at many places shows cross-bedding. [illegible] sh-weathering chert occur sporadically.

[illegible] is w[illegible] presence o[illegible] on, 1937) at the bas[illegible] ilar con- the basal [illegible] (?) forma[illegible] ark red- angular d[illegible] ch occur [illegible] In th[illegible] -A', the 463) rep[illegible] ndance:

Above the transitional zone are two massive quartzite members, each about 200 feet in thickness, separated by 45 feet of dolomite. The latter rock, which is gray in color and quite sandy, occurs in poorly defined beds 1 to 3 feet thick. Pebbles and cobbles of dolomite and quartz are common within the topmost 5 feet (fig. 6a).

The quartzite, from both below and above the dolomite, is gray to brownish-gray on the fresh surface and weathers to a dark reddish-brown. The major constituent is quartz in well-rounded to sub-angular grains. The rock ranges from platy to somewhat massive-bedded and a few micaceous shaly zones occur. The material in some layers is well-sorted, that in others is not; in some places pebbly lenses occur and cross-bedding is well-developed. The upper of the two quartzites is distinctive because the weathered surfaces of many of the layers are "pock-marked" by shallow cavities ranging from a half to 2 inches in diameter and averaging less than half an inch in depth. The sand grains which line individual cavities are coated with a thin film of black iron oxide which extends into the rock as cementing material. Within a fraction of an inch the black oxide gives way to reddish-brown oxide which in turn grades into what seems to be pure silica cement. The "pock-marking" appears to be due to the weathering of localized portions of the quartzite which are cemented by iron oxide. Fresh samples of the rock are dense and show no openings.

The 720 feet of beds which follow are poorly exposed, for the rock breaks down easily to form a fairly complete talus cover. The member is dominantly sandstone and shale but a few layers of clayey and sandy dolomite are present. The sandstones, which occur in beds up to 2 feet thick, are fine-grained and well-sorted. Their chief constituent is clear quartz in well-rounded grains. Feldspar is not uncommon and flakes of muscovite or bleached biotite are present in sufficient number to give parting surfaces a "spangled" appearance. As a rule the rock is light yellow-brown on a fresh surface though some layers are light gray to pale lavender-gray when freshly broken. The latter type of sandstone commonly develops a weathered surface which is finely banded in light gray and reddish-brown. This is in contrast with the dark-brown color shown by most of the weathered rock.

Shales interbedded with the sandstones and in some cases grading laterally into them, appear when slightly weathered as somewhat massive layers 1 to 2 feet thick. More complete weathering results in the development of the platy to shaly character commonly displayed. Light tan to brown on the fresh surface, the shale commonly weathers to a dark-chocolate color. Some layers are distinctive in showing a fine lamination and in the presence of very small white spots which have angular outlines and are possibly much altered feldspar. While the evidence is by no means conclusive, the writer believes that the shales here described may be in part of volcanic origin. It [illegible] of note, in this regard, that L. F. Noble (written communicati[illegible] who independently examined this same section reached a sim[illegible] clusion. Final proof awaits detailed petrographic study.

The sandstone and shale unit is followed by 130 feet of [illegible] dish-brown, cross-bedded quartzite, in the basal portion of whi[illegible] thin greenish-gray shale partings. Along the line of section [illegible] remaining 735 feet of the formation includes in order of ab[illegible]

greenish-gray to maroon clay shales; yellow-buff to mustard-colored sandy dolomite, oolitic in part; reddish-brown quartzite and brownish to greenish sandstone; dolomitic sandstone; and gray dolomite. The maroon shale occurs only in the upper 200 feet of the formation where it is interbedded with greenish-gray shales and sandstone. Parting surfaces on the shale show rain-drop (?) impressions and ripple marks (fig. 6b) and some of the interbedded greenish standstones are cross-bedded. The yellow-buff to mustard-colored dolomite is a distinctive bed because of its color and oolitic character (fig. 6c). In the lower 10 feet of the member at least 75 per cent of the rock mass is composed of roughly spherical to ovoid ooliths which individually show a well-developed radiate structure when etched with acid.

The upper 350 feet of the formation shows marked lateral change in lithology. Within a mile south of the measured section both the maroon shale and yellow-buff, oolitic dolomite grade into greenish-gray to buff-weathering shale. Almost due east of the Gunsight mine and 1¼ miles south of section A-A′, the upper 100 feet of the greenish shale grades, within about 500 feet along the strike, into dark reddish-brown, fine-grained cross-bedded quartzite in beds averaging a foot in thickness. Shale partings are common and the quartzite encloses small lenses of light-brown-weathering dolomite. No pebbly material was observed. That this quartzite should be included within the Johnnie (?) formation rather than the Stirling quartzite is shown by its lateral gradation into shale and its lithologic character as compared with the basal Stirling. In contrast, the basal portion of the Stirling has an average lighter brown color, is more massively bedded, and contains neither shale partings nor dolomite lenses. Likewise, many of the pebbles in the Stirling are reddish-brown quartzite, similar to, but not necessarily derived from, the quartzite of the Johnnie (?) formation.

The contact between the Johnnie (?) formation and the Stirling quartzite is quite sharp and is easily discernable except where the topmost beds of the Johnnie (?) are quartzite. Field relations suggest the possibility of a disconformity but sufficient evidence is not yet available to definitely prove the presence of such a break. Along the line of section A-A′ the base of the Stirling rests on maroon shale; about 500 feet south, 10 feet of dolomite and several feet of greenish-gray shale are present between the maroon shale and the quartzite; and within a few hundred feet farther south the dolomite disappears and the quartzite rests directly on the greenish shale. Since lateral change is characteristic of Johnnie (?) lithology, and in view of the rather poor exposures and the possibility of obscure minor faulting, these apparent relations must not be given too great an importance. Additional factors of some diagnostic value are: (1) the sudden change from a unit of variable lithology to one dominantly quartzitic; (2) the presence of coarse-grained pebbly to cobbly sandstone and quartzite at the base of the Stirling; (3) the occurrence of quartzite pebbles in the basal Stirling beds which could have been derived from the Johnnie (?) formation and (4) a somewhat questionable appearance of slight angular discordance between the two formations.

In the northwest portion of the Spring Mountains, Nolan (1928: 463) reports the Johnnie-Stirling contact to be a thrust plane along

which there is strong angular discordance between the two units. In the Desert Range, northeast of the type locality, Longwell (written communication, 1936) reports no erosional break between units which he correlates with the Johnnie formation and the Stirling quartzite. He notes that as yet it has not been possible to place the exact boundary between them.

Thickness: The Johnnie (?) formation was measured northeast of the Gunsight mine where a maximum thickness of 2,550 feet was obtained. At its type locality where the base of the formation is not exposed and its upper limit is a thrust plane, the Johnnie formation is reported to have a minimum thickness of 4,500 feet.

Age and correlation: No fossils were obtained from the Johnnie (?) formation in the Nopah-Resting Springs area. The lithologic character of the unit and its relationship to the very distinctive Stirling quartzite above have been deemed sufficient evidence for tentative correlation with the Johnnie formation named and described by Nolan (1929:461-463), in the northwest portion of the Spring Mountains 25 miles northeast of the Nopah Range, as well as its inclusion within Lower Cambrian.

Stirling quartzite (Lower Cambrian)

Distribution: The bold, northeast trending ridge which reaches a maximum elevation of about 4,000 feet, 1½ miles east of the Gunsight mine in the southern portion of the Nopah Mountains, is developed on the Stirling quartzite. This formation, originally named by Nolan (1929:464) in the northwest portion of the Spring Mountains, Nevada, has an outcrop width averaging 3,000 feet and is traceable for at least 4 miles in a southeasterly direction from the southern edge of Chicago Valley to near the Noonday mine. The formation is present also in the low foothills and along the lower slopes of the west front of the Nopah Range 2 to 4 miles north of Emigrant Pass. Its exact northern limit is not known but is definitely south of parallel 36° (northern edge of the Avawatz Mountains quadrangle). In the Resting Springs Mountains an eastward dipping, dark-brown, resistant quartzite forms the hills which make up the southernmost 1½ miles of the range north of Resting Springs. This rock is correlated tentatively with the Stirling quartzite.

Lithology: In the southern end of the Nopah Range the Stirling quartzite is divisible into three members. The lower 1,000 feet comprises chiefly dense, fine- to very coarse-grained, light-gray to pinkish quartzite, which weathers to a light reddish- or purplish-brown color. Beds average 2 feet in thickness, but platy layers and beds as much as 6 feet thick are not uncommon. Indistinct cross-bedding is present throughout the member. Lenses of small, well-rounded quartz pebbles are characteristic of the lower portion. In some places the basal 50 feet contains well-rounded pebbles and cobbles set in cross-bedded sandstone, which has foreset beds 4 to 5 feet across. At a few horizons purplish to greenish-gray siliceous shales occur as partings between the quartzite lawers. In the upper portion the parting surfaces commonly show well-developed ripple-marks (fig. 6).

The middle 175 feet of the formation is chiefly greenish-gray to reddish-brown, shaly to platy, partially micaceous sandstone interbedded with reddish-brown, sandy micaceous shale. Thin lenticular gray dolomite beds are present. Many of the parting surfaces of the shaly sandstone are ripple-marked (fig. 7) and some show poorly preserved mud cracks. In the upper part of the member the platy sandstone contains many lenses and thin beds made up of clay-galls (?) set in a fine-grained micaceous, sandy matrix. On the parting surface these fragments give the rock the appearance of a conglomerate composed of very thin, flat-lying pebbles (fig. 6d).

The topmost 1,200 feet of the formation comprises medium to coarse-grained quartzite very similar to that in the lower portion. The rock is gray to nearly white on the fresh surface but weathers to a light reddish-brown. Beds range from 1 to 4 feet in thickness, and nearly all show well-developed cross-bedding. Pebbly material is almost entirely lacking.

Thickness: Along the line of the section measured northeast of the Gunsight mine the Stirling quartzite is 2,593 feet thick. At its type locality about 30 miles northeast the formation is 3,700 feet thick.

Age and correlation: The Stirling quartzite is assigned to the Lower Cambrian for it lies conformably beneath the Wood Canyon formation, which contains Lower Cambrian fossils in its upper portion. On the basis of its relation to the fossiliferous beds above, and its close lithologic similarity with the Stirling quartzite in the northwest portion of the Spring Mountains which was named and described by Nolan (1929:463), it is correlated with that unit.

Wood Canyon formation (Lower Cambrian)

Distribution: The Wood Canyon formation, the uppermost formational unit referred to the Lower Cambrian, has the greatest areal distribution of any Lower Cambrian unit in the Nopah-Resting Springs region. In the southern portion of the Nopah Range, west and east of summit 4,215, a complete section of the formation is exposed over a belt about a mile wide. About 2 miles southeast of summit 4,215 the rocks pass under the valley alluvium near Tule Holes; to the north they are continuously traceable along the west front of the mountains until cut off by faulting approximately 6 miles north of Emigrant Pass. The formation not only crops out in the low foothills south of the pass, but north of the pass it extends high on the mountain front, where it is exposed over a large area west of summit 5,810.

In the Resting Springs Range the upper members of the formation appear in discontinuous outcrops along the west base of the mountains from a point about 1½ miles north of Resting Springs to about 17 miles north of the Shoshone-Pahrump road, a total distance of about 22 miles. No detailed observations were made north of the highway. The formation is also known to be present at the west base of Eagle Mountain, 18 miles north of Shoshone, as well as on the west front of the small mountain area immediately west of Shoshone. The name "Wood Canyon" is the one given to rocks of similar age and lithology in the northwestern portion of Spring Mountain, Nevada, by Nolan (1929:464).

Lithology: In the columnar section (fig. 3d), the Wood Canyon formation is divided into 15 members, to facilitate detailed description. For the more general summary of the lithology, however, such sub-division is not attempted.

At the base of the formation is 400 feet of sandstone and shale, in which a few sandy and clayey dolomite zones ranging from 1 to 30 feet in thickness occur. The sandstone is a dense, fine-grained, quartzose rock, which weathers to a dark-brown or olive-brown. Thickness of individual beds ranges from 6 inches to 3 feet; some layers are cross-bedded. Sandy, micaceous shale, interbedded with the sandstone, forms about 50 per cent of the member. These shale beds are commonly greenish-gray, but some zones weather to a reddish-buff color.

Above this basal member is over 400 feet of sandstone which has rather distinctive lithologic characteristics. For the most part this sandstone is a coarse- to very coarse-grained reddish-weathering rock composed chiefly of poorly sorted, well-rounded to subangular quartz grains. Well-rounded fragments of reddish jasper and thin lenticles of maroon or black micaceous shale are common minor constituents. Thin, lenticular pebble-beds and sporadically distributed pebbles occur throughout the sandstone. The pebble material is generally quartz, but red jasper pebbles are present as well as angular fragments of shale similar in all respects to that present as thin partings throughout the member. The average size of the pebbles is less than one-half inch; in no instance were any seen with a diameter greater than 1 inch. Individual layers range from 6 inches to 6 feet in thickness and almost all show well-developed cross-bedding. Ripple-marked bedding surfaces are present.

In the basal 50 feet of the sandstone unit, dark-maroon fine-grained sandy shale occurs in continuous beds as much as 6 feet thick, and as thin lenticular layers. The sandstone associated with the shale is a weakly cemented, poorly sorted, cross-bedded grit in which occur well-rounded quartz and jaspar pebbles averaging between an eighth and half an inch in diameter. Maroon shale fragments, in part rounded, but more commonly angular in outline, are present sporadically in the more pebbly zones. The outlines of these fragments, as is apparent when the rock is broken across, are not sharp and well defined; the surrounding sand grains project into the shaly material as though pressed in when the shale was still somewhat plastic.

Some 700 feet of dense, reddish-brown-weathering, gray quartzite lies above the reddish sandstone. The rock is commonly coarse-grained near the base but becomes progressively finer upward where the uppermost portion is a white, fine-grained, "saccharine" quartzite. The coarser-grained lower portion is characterized by lenses and thin discontinuous beds of gritty and pebbly material. Some of these zones contain not only well-rounded quartz pebbles, but also large numbers of angular to subangular maroon shale fragments as much as an inch across. The bedding planes range from 6 inches to 2 feet apart and many of them are marked by thin laminae or lenses of micaceous maroon shale. Cross-bedding is commonly developed throughout the unit.

The unit which follows the quartzite is composed of 435 feet of light-brown to greenish-gray, fine-grained quartz sandstone interbedded

with sandy micaceous shale. Some of the sandstone occurs in massive beds as much as 3 feet thick, but most of it is in layers 1 to 6 inches thick which split into well defined slabs or plates a quarter to half an inch in thickness. The greenish-gray shale is usually fine- to very fine-grained and splits into thin irregular plates when weathered. In the upper 90 feet of this member the weathered surface of many of the sandstone slabs shows the sand-casts of trilobite fragments and brachiopod shells. (Coll. N1).

The sandy and shaly fossiliferous zone is overlain by a 120-foot dolomite unit which can be recognized easily both in the southern end of the Nopah Range, and north of Resting Springs along the west front of the Resting Springs Range. The top of the unit served as the common horizon for relating the top of section A-A′, near the Gunsight mine to the base of section B-B′ north of Resting Springs. The dolomite is a dense, dark-gray, partially crystalline rock, which, when dissolved in acid, yields a large amount of very fine-grained, angular quartz sand. The weathered surface commonly develops a dirty-brown color which in some places is streaked and mottled with rusty-brown or buff. Some layers of the dolomite contain sufficient sand to show a poorly developed cross-bedding. Dark-brown-weathering, locally cross-bedded quartzite layers are present a short distance above the base and in the topmost portion of the member. The dolomite is overlain by 150 feet of gray, somewhat micaceous, platy shale in which occur dark-brown-weathering, fine-grained sandstone beds 6 inches to 1 foot in thickness.

The shale is followed by a very distinctive member, 160 feet thick, for which the name *Zabriskie quartzite* is here proposed.[6] Stratigraphically the top of this unit is 630 feet below the top of the Wood Canyon formation. The member is distinctive because of (1) its weakly cliff-forming, somewhat massive character; (2) its salmon-pink to rusty-brown weathering surface; (3) the constancy of its lithologic features; and (4) its continuity of outcrop throughout all exposures of the upper Wood Canyon formation in the Nopah-Resting Springs area. The member is easily recognizable on the western slope of the Resting Springs Range. From a point about 1½ miles north of Resting Springs it can be traced northward along the mountain front for about a mile. It appears again about 1½ miles south of the Shoshone-Pahrump road, from which point it is continuously traceable as far north as the highway. In the Nopah Range the member forms dip slopes on the eastern side of a series of low foothills north and south of Emigrant Pass. About 2 miles north of the pass, faulting off-sets the bed to the eastward, and it crops out high on the range front. Some distance south of the pass the unit forms the top of summit 4,215 and a portion of the dip slope on its eastern side.

In detail, the upper 100 feet of the member consists of massive, indistinctly cross-bedded, fine- to medium-grained, fairly well-sorted, pinkish to light-gray quartzite in beds 1 to 6 feet thick. The weathered surface is characteristically salmon-pink to rusty-brown in color. Below the upper 100-foot massive portion, the unit grades into reddish-

[6] The name is derived from Zabriskie Station on the Tonopah and Tidewater Railroad in Amargosa Valley west of the Resting Springs Range.

brown, sandy shale and medium- to coarse-grained shaly quartzite and sandstone, locally conglomeratic. The basal 10 feet of the member is light gray to nearly white, reddish-brown-weathering massive quartzite. In the basal portion there occur many vertical tube-like structures, circular to oval in cross-section and an eighth to half an inch in diameter (figs. 6e and f). Some of these tubes are several inches in length and cut across the bedding planes in the rock. A few of the forms show blunt, rounded lower ends. Many of the structures do not maintain a constant diameter throughout their length but thicken and thin to produce a somewhat segmented appearance. All of the tubes are filled with well-cemented sandy material and occasionally these stem-like fillings can be readily separated from the surrounding rock. The origin of such structures is not definitely known, but they are usually assumed to be sand-filled burrows of forms like *Scolithus*. These are characteristic of the base of the Zabriskie quartzite in both the Nopah and Resting Springs Ranges. The upper beds of the Zabriskie in Emigrant Pass show horizontal worm (?) castings and ripple-marks.

The 630 feet of beds between the top of the Zabriskie quartzite and the top of the Wood Canyon formation is of diverse lithology, in general comprising platy quartzite and sandstone, greenish-gray to buff shale, and gray to orange-buff-weathering limestone. Immediately above the Zabriskie quartzite is 115 feet of rusty-brown-weathering, dark-gray to grayish-brown quartzite and sandstone, in beds 3 inches to 2 feet thick, interbedded with dark greenish-gray platy, sandy micaceous shale. Much of the quartzite shows a fine horizontal lamination on the weathered surface, other portions show poorly developed cross-bedding. Ripple- and rill-markings (fig. 8) are well developed on some of the parting surfaces. Interestingly enough, the rill-markings suggest that the body of water was to the east and the strand to the west. At present the strike of the ripple-mark troughs and crests is about N. 20° W. The shales associated with the quartzite and sandstone occur as distinct beds ranging from a few inches to several feet in thickness. The relative proportion of shale to sandy material varies along the strike. Most of the shale breaks into irregular platy fragments and contains sporadic grains of glassy green glauconite as well as nodular concretions one-half inch or more in diameter.

The 340 feet of beds which overlie the sands and shales comprise a lower shale unit about 106 feet thick, a middle limestone member approximately 110 feet in thickness, and an upper shale 125 feet thick. Lithologically the two shale members are very similar; both contain comminuted trilobite and brachiopod remains. Determinable fossils were obtained from both shale zones at horizons about 400 and 200 feet below the top of the formation (Coll. R8; and Coll. R10, respectively). Usually the shales are light-gray to greenish-gray in color and sandy or micaceous. Most of the rock splits along irregular parting surfaces into platy or sliver-like fragments averaging a quarter of an inch in thickness. In the upper shale unit glauconite is common in the more sandy portions; in the upper part of the lower unit there occur irregular, discontinuous layers, 1 inch to 1 foot in thickness, of light brown to grayish-brown, light buff-weathering limestone. Some of the limy zones are rich in fossil fragments.

The middle limestone zone is a light-gray, gray to orange-buff weathering, clayey rock with greenish-gray shale interbeds. As a rule, the layers range from 2 to 3 feet thick, but on weathering they split along irregular parting surfaces into somewhat nodular or "bumpy" plates half an inch to an inch in thickness. Along the strike the relative proportion of limestone and shale shows marked variation. Comminuted trilobite debris and algal (?) nodules are common.

About 175 feet below the top of the Wood Canyon formation is the base of a distinctive 95-foot limestone member which, in the opinion of the writer, is the probable correlative of lithologically similar limestones occupying about the same stratigraphic position in several Lower Cambrian sections in southeastern California and Nevada. No member name is proposed for this unit in the Nopah-Resting Springs area, but it will be referred to as the algal limestone, a term which has been used at other localities (Hazzard and Mason, 1936:230-231).

The algal limestone member comprises dark- to light-gray, dense, clayey to sandy, fine- to medium-grained limestone with lenticular layers of greenish-gray sandy micaceous shale and dark chocolate- to reddish-brown, limy sandstone which vary in thickness and number along the strike. The limestone occurs in beds as much as 6 feet thick, and in the middle portion of the member many of these massive layers show distinct dark-gray bands an inch or so wide, separated by 6 inches to 1 foot of light gray rock. Near the base is a thin layer of orange-buff-weathering clayed limestone which is traceable for at least 1,000 feet along the strike. The middle portion of the member and the uppermost few feet are characterized by the presence of algal nodules. These nodules, which average between 1 and 2 cm. in diameter, are roughly ovoid bodies which, on weathering, show a poorly developed concentric structure and, commonly, a darker color than the surrounding limestone matrix (fig. 9). Their number and distribution are variable along the strike; in some instances, where they are small and concentrated in thin zones, they give the rock a grossly pisolitic appearance.

The top of the Wood Canyon formation has been tentatively placed about 80 feet above the top of the algal limestone immediately above a 1- to 2-foot, buff-weathering limestone bed which lies at the top of light greenish-gray, calcareous, micaceous, sandy shales assigned to the Lower Cambrian, and below purplish to maroon shales tentatively assigned to the Middle Cambrian. That the topmost limestone is more than a local feature is indicated by its occurrence not only along section B-B′ in the Resting Springs Range, but also by its presence in the Emigrant Pass region. The topmost Lower Cambrian shale contains within it two reddish-buff-weathering limestone layers 1 to 2 feet thick, and lenticular sandy zones a few inches in thickness which commonly enclose concretion-like masses 4 to 6 inches in diameter. Fucoid (?) markings are common.

Thickness: A thickness of 3,033 feet is tentatively assigned to the Wood Canyon formation in the Nopah-Resting Springs region. Exact thicknesses can not be given to either this unit or that overlying because of uncertainty concerning the position of the Lower-Middle Cambrian boundary. At its type locality in the Spring Mountains, Nolan (1929: 463-464) placed 2,100 feet of beds in the Wood Canyon formation.

Age and correlation: The Lower Cambrian age of the Wood Canyon formation is well established by fossil collections made in the upper portion. Concerning them Mason reports as follows:

"*Collection No. N1:* From member (E) of the Wood Canyon formation. Fossiliferous zone approximately 1,100 feet below the top of the formation. *Locality* along the line of section A-A', about a quarter of a mile northwest of summit 4,215 in the southern end of the Nopah Range.

Mesonacis fremonti Walcott
Wanneria ? gracile Walcott
Oboella vermilionensis Walcott
Hyolithes sp. indet.
Cystoid plates

"*Collection No. R8 and R10:* From member (K) and (M) respectively, of the Wood Canyon formation. Fossiliferous zone (M) approximately 200 feet below the top of the formation. *Locality* along the line of section B-B', about 2¾ miles north of Resting Springs on the west slope of the Resting Springs Range.

Mesonacis fremonti Walcott
Paedumias clarki Resser"

Mr. Mason further reports:

"Apparently our collection N1 came from horizons near Walcott's (1912) localities 14-1 and 14o. In the Resting Springs Range our collections R8 and R10 are similar to that reported by Walcott from locality 14p (near Resting Springs)."

On the basis of lithology and fauna this formation is correlated with the Lower Cambrian Wood Canyon formation of the northwestern portion of Spring Mountain, Nevada (Nolan, 1929:463-464), although it includes more beds than were placed in the formation by Nolan at the type locality.

The faunal assemblage contains forms reported from many Lower Cambrian sections in southeastern California and Nevada. Some of the nearest of these areas are the Marble and Providence Mountains, California (Hazzard, 1933:71), and the Pioche District, Nevada (Westgate, 1932:10).

The Lower-Middle Cambrian boundary

In that portion of the Great Basin where rocks yielding Lower Cambrian fossils lie below fossiliferous Middle Cambrian beds, the position of the exact Lower-Middle Cambrian boundary is a problem which so far has not been satisfactorily solved. In the present report the provisional placing of the boundary 80 feet above the top of the algal limestone member of the Wood Canyon formation is based upon data obtained at other localities (see Hazzard and Mason, 1936a:230-231). Recent study of approximately 20 sections in southeastern California, southern and central Nevada, western Utah, and northwestern Arizona, by J. F. Mason and the writer, has supplied much valuable data on the boundary problem which, however, can not be reviewed at present.

The section nearest the Nopah-Resting Springs area in which the problem of the Lower-Middle Cambrian boundary figures, is that described by Nolan (1929:461-464) in the northwestern portion of the Spring Mountains, Nevada, about 25 miles northeast of the Nopah Range. There Nolan proposed the terms "Johnnie formation," "Stirling quartzite," and "Wood Canyon formation" for lithologic units of Lower Cambrian age, and used the term "Bright Angel shale" for a Middle Cambrian unit of variable lithology. In order to make his viewpoint on the position of the Lower-Middle Cambrian boundary clear, the descriptions of the Wood Canyon formation and the "Bright Angel shale" are quoted below in their entirety.

"*Wood Canyon formation:* Above the Stirling quartzite are 2,100 feet of thin-bedded quartzitic sandstone, sandy shales, and, near the top, a very few limestone beds. These are here named the Wood Canyon formation, from exposures in Wood Canyon, about 4 miles south of Crystal Springs on the west side of the range. The lower quarter is composed of brown micaceous shaly sandstone with some thin beds of dark quartzite. Above this is about 1,000 feet with only minor amounts of shaley material, much of which forms partings between the quartzite beds. At the base of this division the quartzites are coarser-grained, or even, particularly in the central part of the individual beds, rather pebbly. Some of the pebbles are as much as an inch in maximum diameter, although the greater number are less than half an inch. In the highest portion, shales and sandy shales are again abundant and one or two gray sandy limestones are present. Throughout the formation shallow water phenomena, such as cross-bedding, ripple marks, and suncracks, are of common occurrence, and many of the beds are lenticular. Fossils were found in a quartzitic bed about 150 feet below the top of the formation on the north side of Wood Canyon. These were identified by Professor Schuchert of Yale as "probably *Olenellus fremonti*," indicative of Lower Cambrian age.

"*Bright Angel shale:* Above the Wood Canyon formation are 1,500 feet of shales and limestones with minor amounts of quartzite near the base. The base of the formation is marked by a 20-foot bed of white quartzite which contains a few pebbles both at the base and top. It apparently slightly transgresses the uppermost beds of the Wood Canyon formation. Above this bed are some 200 feet of interbedded reddish quartzites and green shales, including near the base a rather persistent horizon of red hematitic shale. The remainder of the formation is made up of greenish shale, much of it calcareous, and thin bedded limestones. The limestones are largely of a type prevalent in the western Cambrian, layers up to one inch in thickness of dark blue limestone, separated by thinner bands of shaly material that weathers brownish or reddish. Oolitic beds are present but not abundant. Several lots of poorly preserved fossils submitted to Dr. C. E. Resser of the Smithsonian Institution were reported by him to show affinities to the fauna of the Bright Angel shale which is now thought to be of Middle Cambrian age. According to Longwell the formation has the position and character of the Bright Angel shale, which occurs in several ranges east of this area and in the Grand Canyon."

The above described units and the Stirling quartzite were examined by J. F. Mason and the writer along the ridge on the north side of Wood Canyon. In light of information obtained in both the Nopah-Resting Springs section and at other localities, the writer would place the Lower-Middle Cambrian boundary much higher in the Spring Mountains section than was done by Nolan.

The combined thickness of Wood Canyon formation and "Bright Angel shale" as measured by Nolan is 3,600 feet; the thickness of the Wood Canyon and Cadiz formations combined, in the Nopah-Resting Springs section, is 3,725 feet; a comparable figure. In both regions the base of the Wood Canyon formation at the top of the Stirling quartzite is an easily recognizable horizon; similarly, the base of the massive "limestones" which overlie the "Bright Angel shale" and the Cadiz formation is a distinctive reference plane. These relationships, plus the known lithologic and faunal similarity between the beds in the two areas, establish the very strong probability of their stratigraphic equivalence.

Nolan placed the base of the "Bright Angel shale" at "a 20-foot bed of white quartzite." This unit, where examined in Wood Canyon, resembles in many other ways the topmost portion of the Zabriskie quartzite member of the Nopah-Resting Springs section. Likewise, the "200 feet of interbedded reddish quartzite and green shales" reported immediately above the 20-foot quartzite member are similar in character to beds above the Zabriskie quartzite. No zone was found at Wood Canyon that could be correlated definitely with the algal limestone of the Nopah-Resting Springs section, but as talus and forest-cover are heavy and the time available for the examination was short such an apparent lack is not considered of critical importance.

On the basis of the data summarized above, the writer believes that further investigation will show the Lower Cambrian beds at Wood Can-

yon to be several hundred feet thicker than indicated by Nolan. Also it seems reasonable to correlate the "20-foot white quartzite" with the Zabriskie quartzite member of the Nopah-Resting Springs section. Nolan's usage of the term "Bright Angel shale" must be questioned, and it is suggested that the term "Cadiz formation" be extended to the northwestern portion of Spring Mountain to include the Middle Cambrian shales and thin-bedded limestones.

Cadiz formation (Middle Cambrian)

Distribution: The Cadiz formation, which is the lowest unit of the Middle Cambrian series, occurs in both the Nopah and Resting Springs Ranges, as well as at the west base of Eagle Mountain, 18 miles north of Shoshone, and on the west face of the mountain area immediately west of Shoshone.

The formation can be traced southward along the west front of the Nopah Mountains from the northern boundary of the Avawatz Mountains quadrangle (parallel 36°) to the saddle which lies immediately east of summit 4,215 in the southern portion of the range. At its northernmost limit the formation crops out low on the range front and is encountered along the line of section C-C′. When viewed from the west side of Chicago Valley these outcrops appear as a reddish-buff zone overlain by very massive, dark smoky-gray beds. About 2 miles south of section C-C′ the Cadiz beds are offset to the east by cross-faulting, and crop out high on the range front along which they can be followed to a point about 2 miles north of Emigrant Pass. At this point, faulting shifts the beds westward, and immediately north and south of the west end of the pass the formation is near the base of the range. It is excellently exposed in the pass on the north side of the wash (fig. 10). To the south the unit can be traced through the saddle east of summit 4,215.

In the Resting Springs Range the Cadiz is well exposed. It crops out about 3½ miles north of Resting Springs and can be traced northward along the west front to the Shoshone-Pahrump road, where the continuity of outcrop is interrupted by faulting. The beds occur further north in the range, but were not examined in detail.

The Cadiz is a distinctive lithologic unit, for the orange to reddish-buff color which is characteristically developed in its upper portion makes it easily recognizable. The color is particularly outstanding, for it is emphasized through contrast with the very dark smoky-gray, massive-weathering dolomitic limestone of the overlying formation.

Lithology: As studied along the line of section C-C′ in the Resting Springs Range north of Resting Springs, the Cadiz formation comprises in order of abundance: gray to buff limestone, greenish-gray to maroon shale, and brownish sandstone. The basal 150 feet are made up of purplish to maroon micaceous shale within which occur shale zones of a greenish-gray color as well as occasional mottled, gray to buff, partially dolomitized limestone beds ranging in thickness from 6 inches to 10 feet. Some of the shale splits into paper-thin flakes; other portions break into irregular fragments an eight to a quarter of an inch in thickness. Maroon shales are characteristic of the basal portion of the Cadiz formation not only in the section here described but likewise at the type locality (Hazzard and Mason 1936a:240).

In the 210 feet of beds following the maroon shale zone the lithology is quite variable, though the rocks are predominantly calcareous. The basal 55 feet, which is somewhat massive-weathering and weakly cliff-forming, comprises gray to buff, in part platy to sandy limestone, which shows reddish-brown mottling at some horizons. Interbedded greenish-gray shale, in discontinuous zones a few feet thick is common. Along the line of section B-B′ the following 120 feet of beds is mainly fine-grained, platy to shaly, gray to pinkish limestone, which carries a large amount of sand and clay. Many of the layers are lenticular and some show poorly preserved mud-cracks on the bedding surfaces. Greenish-gray, micaceous shale occurs as partings between the limestone beds and as individual layers as much as 15 feet in thickness. In Emigrant Pass this unit is very similar but contains a larger proportion of platy buff limestone and shale. Overlying these beds is a massive-weathering, weakly cliff-forming dark-gray limestone 35 feet thick. In its upper portion this limestone contains lenticular zones and irregular splotches of reddish-brown-weathering clay material.

About 140 feet of interbedded gray limestone and rusty-brown sandstone in beds a few inches thick comprises the next unit. Greenish-gray shales and ripple-marked, brownish, shaly sandstone occur in the upper portion. Thin layers in the topmost few feet of the unit contain comminuted trilobite fragments and fucoid (?) markings.

The topmost member of the Cadiz is the most distinctive unit within the formation, and can be readily recognized wherever the formation occurs. This zone was described from the type locality as follows (Hazzard and Mason, 1936a :230-231) :

> "The topmost portion of the Cadiz formation consists of 75 feet of thin-bedded, platy-weathering limestone, lenticular and more or less nodular, interbedded with mudstone material, which causes the weathered surface of the limestone plates to be irregularly mottled with light-gray, buff and brown (fig. 11a). The content of buff-colored material is variable along the strike, but usually it is present in sufficient amount to give the horizon a decided yellowish-brown color when seen from a distance."

The above description serves equally well for the rocks in the Nopah-Resting Springs area, though the buff to orange-buff color is more pronounced, and the unit is about 190 feet thick. Middle Cambrian fossils were obtained from the basal 20 feet of the member.

Due to the marked color contrast between the upper member of the Cadiz formation and the overlying dark-gray beds, the contact usually appears quite sharp; actually, however, it is more or less gradational for a few reddish-buff-weathering zones are present in the basal portion of the unit above. Along the front of the Resting Springs Range the top of the Cadiz looks irregular. From a distance an unconformity appears to be present, but close examination shows that the relation is due entirely to strike faulting.

Thickness: The Cadiz formation was measured about 3½ miles north of Resting Springs along the line of section B-B′ where 692 feet of beds were tentatively assigned to it. At the type locality in the Marble Mountains, 120 miles southeast of the Resting Springs Range, the formation is 375± feet thick.

Age and Correlation: A Middle Cambrian age is established for the Cadiz formation by somewhat meager fossil collections made about

180 feet below the top of the formation. The collections were examined by Mason who reports as follows:

"*Collections No. R23:* From the basal portion of member (G) of the Cadiz formation. Fossiliferous zone approximately 180 feet below the top of the formation. *Locality* along the line of section B-B′, about 3½ miles north of Resting Springs on the western slope of the Resting Springs Range.

Alokistocare strangulatus Mason
Hyolithes sp."

The trilobite is characteristic of the type Cadiz and was first described (Mason, 1935:106 and note, p. 117) from the Marble Mountains. At its type locality the Cadiz formation contains a fauna comparable with that of the Chisholm shale near Pioche, Nevada, and thus may be regarded as lower Middle Cambrian in age.

On the basis of lithology and fauna the Cadiz formation of the Nopah-Resting Springs Ranges is correlated with the Cadiz formation of the Marble and Providence Mountains. Tentatively, it is considered equivalent to a large portion of the unit described by Nolan (1929:464) as the "Bright Angel shale" in the northwestern portion of Spring Mountain, Nevada.

Bonanza King formation (Middle Cambrian)

Distribution: Beds corresponding in stratigraphic position and lithology to the Bonanza King formation of the Providence Mountains (Hazzard and Mason, 1936:234-235) crop out in both the Nopah and Resting Springs Ranges. Most of the summit portion of the Nopah Range south of the northern boundary of the Avawatz Mountains quadrangle (parallel 36°) is formed by rocks of this formation. In the Furnace Creek quadrangle, the unit occurs near the base of the range where it was encountered along sections C-C′ and D-D′. The formation is known to extend for several miles north of section D-D′ but the northern limit was not determined.

Almost the whole of the Resting Springs range, with the exception of the lower western slopes and a few small areas on the east side, is formed by the Bonanza King formation. It has been traced from about 3½ miles north of Resting Springs to at least 20 miles north of the Shoshone-Pahrump road. The eastward-dipping, dark gray dolomites which form a portion of the hills immediately west of Shoshone are correlated with this unit as is the main mass of Eagle Mountain north of Shoshone.

Lithology: Along the western base of the Nopah Range, west of summit 6,415 and near the southern boundary of the Furnace Creek quadrangle, the Bonanza King formation appears as a very massive, dark-gray unit which, in the vicinity of section C-C′, rests on reddish-buff beds belonging in the uppermost portion of the Cadiz formation. The beds at the base of the Bonanza King formation are massive-weathering and form cliffs which rise above the more gentle slopes developed on the Cadiz. The contact between the two formations is sharp when viewed from a distance, though a few reddish-brown-weathering, clayey to sandy limestone layers, similar to those in the uppermost portion of the Cadiz, occur in its lower portion. In the southern Nopah and Resting Springs Ranges, 300 to 400 feet above the base of the formation, there is a zone of very light gray dolomite

which forms an easily recognizable marker bed visible for a long distance. In the Nopah Range, south of Emigrant Pass and for some distance to the north, this unit is consistently present, but it is not discernible southeast of Twelvemile Spring along the line of section C-C′.

The lower 1,050 feet of the Bonanza King formation comprises dark smoky-gray dolomite and dolomitized limestone in beds ranging from 6 inches to 10 feet in thickness. Some of the beds are composed entirely of dark-gray dolomite, but occasionally light creamy-gray dolomitic layers occur. Most of the rock is partially dolomitized limestone (figs. 11b, c, and d) with a compositional range from pure limestone to limestone so completely dolomitized as to show almost no trace of its original character. The basal 415 feet of beds is partially altered limestone in which the estimated limestone-dolomite ratio is 3:1. This type of rock grades upward into a group of beds in which the limestone-dolomite ratio is aproximately 1:3. The upper 445 feet of the 1,050-foot unit is partially dolomitized limestone similar in character to the beds in the lower portion.

Lithologically, the dark-gray dolomite and partially dolomitized limestone closely resemble rocks of similar character which have been described from the Bonanza King formation in the Providence Mountains. As a portion of this description applies equally well to the rocks under discussion it is given below (Hazzard and Mason, 1936a: 235):

> "On weathered surfaces the darker gray beds, as a rule, are irregularly streaked and mottled. Where the rock is entirely dolomitic, the mottling takes the forms of irregular, elongate or rounded, light-colored areas in a darker matrix. In other instances, the colors are reversed, with a dark mottling on a light backgound. When an appreciable limestone content is present, the surface commonly shows irregular streaks of dark, smoky-gray limestone in a slightly lighter gray to brownish-gray dolomite, or light gray dolomite streaks in a limestone matrix. The individual streaks, which are very irregular and not continuous for any great distance, range in thickness from an eighth of an inch to two inches. In some instances the streaked effect is produced by a series of irregular to somewhat lenticular limestone areas strung along a common horizon. Where dolomite constitutes more than 75 per cent of the rock, the limestone remains as small, somewhat scattered lenses, and short, irregular streaks."

About 275 feet below the top of the formation is the top of a 190-foot, dark-gray, partially dolomitized limestone. This is considered the probable correlative of the Silver King dolomite, a distinctive member high in the Bonanza King formation at its type locality. In the Nopah Range the Silver King (?) member is predominantly limestone and only a few beds show alteration to dolomite. Individual layers range from 2 to 3 feet in thickness but they are indistinctly defined on the weathered surface. The member is dark enough in color to stand out from the rocks below and above, and it can be picked out easily when the range front is viewed from Chicago Valley opposite section C-C′.

In the Nopah Range the topmost member of the Bonanza King formation is 275 feet thick. It is made up of dark-gray to smoky-brown-weathering, partially dolomitized limestone in beds 6 inches to 2½ feet thick. Dolomite is predominant in the lower half where it gives the weathered surface a distinctly reddish- to smoky-brown color. From a distance the unit appears light-gray in the upper half and smoky- to reddish-brown in the lower portion. At its upper limit the member passes sharply into the basal member of the overlying formation.

Thickness: Along sections C-C′ and D-D′ the Bonanza King formation is 1,515 feet thick. Approximately 2,000 feet of beds are assigned to the formation at its type locality, and a similar thickness has been reported from the Goodsprings region in Nevada (Hazzard and Mason, 1936b).

Age and Correlation: No fossils have been found in the Bonanza King formation. It is assigned to the Middle Cambrian, however, because it lies between formations of known Middle Cambrian age; the Cadiz formation below and the Cornfield Springs formation above. On the basis of lithologic character and stratigraphic position this formation is correlated with the Bonanza King formation of the Providence Mountains (Hazzard and Mason, 1936a). The formation is equivalent to a large portion of the Goodsprings dolomite, as that term is used by Hewett (Hewett, 1931:11-13; see also, Hazzard and Mason, 1936b) in the Goodsprings quadrangle.

Cornfield Springs formation (Middle Cambrian)

Distribution: The Cornfield Springs formation occurs on the west slope of the Nopah Range within the Furnace Creek quadrangle. The northern limit of outcrop is between sections E-E′ and F-F′. Along the line of section E-E′ the formation crops out along the base of the range. A very short distance to the northward it passes completely under the alluvium of the northern end of Chicago Valley. As far as known, the Cornfield Springs beds do not occur in the Resting Springs Range.

Lithology: The Cornfield Springs formation is composed almost entirely of dolomite and partially dolomitized limestone. On the weathered surface the dolomite ranges from a medium-gray to a light-buff or creamy-gray color. The limestones are usually dark-gray though some very light-gray beds occur. Individual layers range in thickness from 6 inches to 15 feet but probably average between 1 and 2 feet. Several of the members within the formation are distinctly cliff-forming and, as a result, portions of the unit are very difficult of access.

The basal 135 feet of the formation is comprised of fossiliferous limestone, shale, and dolomite (fig. 12). The limestones, usually reddish-brown-weathering because of clay and sand admixture, are interbedded with greenish-gray to brown fossiliferous shales. Dolomite forms the lower portion of the member and is commonly buff-weathering, clayey and sandy.

The formation above the basal member is a somewhat monotonous succession of dolomite and partially dolomitized limestones which can be divided into somewhat indefinite members by means of slight difference in color, degree of dolomitization, or cliff-forming character. The following abridged section gives a general idea of the lithologic sequence:

Top:

Cornfield Springs formation	Feet
(L) Light gayish-cream dolomite in beds 6 inches to 2 feet thick	200
(K) Dark-gray, obscurely-bedded, dolomite. Some beds are mottled or oolitic	200
(J) White to creamy-gray dolomite	75
(I) Very dark-gray dolomite in beds 6 inches to 1 foot thick. Some layers are indistinctly mottled with light-gray	360
(H) Very dark-gray limestone and light creamy-gray dolomite	60
(G) Interbedded dark smoky-gray limestone and dark-gray to creamy-gray dolomite. Beds 6 inches to 5 feet thick. Unit has faintly striped appearance from a distance and is thus distinctive	540
(F) Dark-gray partially dolomitized limestone in beds from 6 inches to 15 feet thick. Unit mainly limestone in basal portion. Cliff-forming	595
(E) Light-buff to light-gray dolomite and light-gray limestone. Minor amount of chert	95
(D) Dark-gray limestone and light-gray dolomite in alternating layers. Much brown chert in middle portion	200
(C) Light and dark smoky-gray dolomite. Beds 6 inches to 2 feet thick	140
(B) Dark smoky-gray dolomite grading into partially dolomitized limestone toward base. Reddish-brown sandy bed at top. Member is cliff-forming	375
(A) Fossiliferous limestone, with shale and dolomite (Coll. P.B. 7A)	135
	2,975

In the central portion of the Nopah Range, members (H) to (L) inclusive of the above outlined section form a very marked and easily recognizable unit high on the range front. This sequence of alternating light and dark gray zones produces the broad "zebra-like" striping referred to by Noble (1934:177).

Thickness: Where measured on the west slope of the Nopah Range the Cornfield Springs formation is 2,975 feet thick. At its type locality in the Providence Mountains the formation is 750 feet thick below a pre-Devonian unconformity (Hazzard and Mason, 1936a:238); in the southern Spring Mountains, near Goodsprings, Nevada, approximately 650 feet of beds, beneath the same unconformity have been assigned to the unit (Hazzard and Mason, 1936b).

Age and Correlation: A collection of well preserved fossils made from the basal member of the formation has been examined by J. F. Mason. A preliminary report follows:

"*Collection No. P.B. 7A:* From member (A) of the Cornfield Springs formation. *Locality* about 1,000 feet south of the line of section D-D′ on the west front of the Nopah Range east of Twelvemile Spring. The Cornfield Springs fauna is characterized by an abundance of pygidia of *Ehmania* and by a large *Linguella*. *Ehmania* is found in the upper Middle Cambrian of Montana and Wyoming, the genotype occurring in the Meagher formation of Yellowstone Park."

On the basis of both the above report and a recent re-study (Mason, Longwell, and Hazzard, 1937) of the faunas from the Cornfield Springs formation at its type locality, as well as from the known stratigraphic position of the beds in relation to the Cadiz and Bonanza King formations, the rocks here termed the Cornfield Springs formation are correlated with the unit of the same name in the Providence Mountains. Further correlations can not as yet be made and will not be possible until more data are available from regions to the north of the Nopah area. Though fossils were found only in the lowest member, the complete unit, 2,975 feet thick, is provisionally assigned to the Middle Cambrian. Since the basal beds of the overlying Nopah formation have yielded a fauna of middle Upper Cambrian (Franconia) age it is possible that a portion of the Cornfield Springs formation may be found to be lower Upper Cambrian. A lower Upper Cambrian (Eau Claire) fauna with *Tricrepicephalus* is known to occur in the Desert Range,

northwest of Las Vegas, Nevada (Mason, Longwell, and Hazzard, 1937).

Nopah formation (Upper Cambrian)

Distribution: The series of beds for which the name Nopah formation is here proposed, crops out in the northern half of the Nopah Mountains. Along the line of section E-E′, the formation occurs between 500 and 1,000 feet above the valley margin; a short distance north of the section the beds pass under the alluvium of Chicago Valley (see fig. 13). The southern limit of outcrop was not determined but the formation appears to be present high on the west front of the mountains as far south as summit 6,412, near the southern boundary of the Furnace Creek quadrangle. As far as is known, the Nopah formation is not present in the Resting Springs Range.

The west front of the Nopah Range, directly east of Twelvemile Spring, is made up entirely of rocks comprising the Nopah and Cornfield Springs formations. If one is acquainted with these units it is possible to pick out practically all of the major subdivisions recognized in the detailed section when the mountain front is viewed from Chicago Valley. Just below the range top appear two thick, creamy-gray beds between which is a distinct dark-gray band of variable thickness, but thinner than the light colored layers with which it is associated. Below these beds is a poorly developed bench, formed by a thin brownish member. This latter unit is the sandy, basal portion of the Nopah formation. In the Cornfield Springs formation which is below, the following units can be recognized in order from the top downward: (1) a medium- to dark-gray cliff-forming unit; (2) a thin, cream-colored zone; (3) a dark smoky-gray, cliff-forming member 250 to 300 feet thick; (4) a unit banded with alternating thin stripes of light- and dark-gray, and weathering to form steep slopes but not developing vertical cliffs; (5) a dark smoky-gray, cliff-forming member; (6) a second banded zone in which the light- and dark-gray stripes are not as distinct as in the one above; (7) a dark gray, locally cliff-forming unit about 200 feet thick which rests upon (8) a bench-forming, reddish-brown-weathering member, the lowest in the Cornfield Springs formation.

Lithology: The basal unit of the Nopah formation, about 100 feet in thickness, resembles the lowest member of the Cornfield Springs formation. About 1,000 feet north of the line of section E-E′, where it is well exposed, it comprises, in order of abundance: (1) dark- to light-gray, reddish-brown mottled, locally dolomitic limestone, in part crinoidal and oolitic; (2) platy, greenish-gray, reddish-brown-weathering shales with lenticular layers of gray limestone; and (3) calcareous sandstones and sandy shales, usually weathering to a dark-brown color. The limestone makes up the upper portion of the member and is interbedded with the shales and shaly sandstones in the lower half. Some of the limestone beds in the middle of the unit contain flat limestone pebbles. Topographically this member forms a distinct bench between the rock units below and above, which are usually cliff-forming.

In addition to the basal 100 feet, 1640 feet of alternating light- and dark-gray dolomites, resembling the banded upper portion of the Cornfield Springs formation, are assigned to the Nopah formation.

There follows a summary of the units placed within the formation along the line of section E-E′:

Top:

Nopah formation	Feet
(G) Light-gray- to grayish-buff-weathering dolomite in beds 3 inches to 3 feet thick. Yellowish-buff-weathering beds in upper portion; chert in middle part	770
(F) Dark-gray dolomite; a few chert nodules. Beds 4 inches to 2 feet thick	185
(E) Creamy-buff to very light-gray dolomite. Layers 6 inches to 2 feet thick. Color changes along the strike	190
(D) Dark-gray, massive dolomite. Beds 4 inches to 2 feet thick	340
(C) Light creamy-gray dolomite	60
(B) Medium- to dark-gray dolomite in well-defined layers 1 to 2 feet thick	95
(A) Limestone, shale, and sandstone	100
	1,740

The above outlined sequence of light- and dark-gray zones is by no means constant throughout the range. About 200 feet south of the line of section the middle portion of unit (E) is marked by a 15-foot, light-gray zone which expands farther south at the exepnse of the adjoining dark-gray rock to a thickness of about 50 feet.

The top of the Nopah formation has been placed, provisionally, at the base of a 25- to 40-foot zone of yellowish-buff-weathering, indistinctly cross-bedded, sandy dolomite, which, along the line of section E-E′, marks quite closely a somewhat distinct lithologic change. The Nopah beds below are dark- to light-gray dolomites nearly free of buff-weathering sand or clay material; the rocks above, here termed the Pogonip (?) dolomite, contain variable amounts of sand and clay and many of the beds weather to a buff or yellowish-brown color.

Where examined in the vicinity of section E-E′ the contact at the base of the Nopah formation is irregular. Study of the boundary at other localities will be necessary before conformity or disconformity of the beds can be established.

Thickness: As measured along section E-E′ the Nopah formation is 1,740 feet thick.

Age and correlation: The basal 100 feet of the Nopah formation has so far yielded the only determinable fossils found within the whole unit, thus it represents the only portion of the formation at present definitely known to be of Upper Cambrian age. The 1,640 feet of beds which lies above is probably placed correctly within the formation but until better faunal collections are made either in the upper Nopah or in the lower portion of the basal Ordovician unit, the boundary between the two can only be approximated.

Study of the collections made from the Nopah formation has not been completed and the following report by J. F. Mason is of a preliminary nature:

"*Collections No. P.B. 8, 8Aa, 8Ab, 8Ac:* From member (A) of the Nopah formation. *Locality* on the west side of the Nopah Range on the south side of the first large canyon north of the ridge along which section E-E′ was measured. Basal member of the formation is well exposed just above the wash level a short distance east of the canyon mouth. Most of the fossils were collected from the thin, lenticular limestone layers associated with the shales. The Nopah fauna is characterized by new species of *Elvinia* and *Pterocephalia;* this association is typical of the *Camaraspis* fauna of the Ironton formation of Wisconsin, of the Davis formation in the Ozarks, of the Honey Creek formation in Oklahoma, and of the Secret Canyon shale at Eureka, Nevada."

In Nevada, Upper Cambrian rocks have been reported in the northwestern Spring Mountains (Nolan 1929:465), 25 miles northeast of the Nopah Range; in the Desert Range, about 60 miles to the northeast (Mason, Longwell, and Hazzard, 1936); and in the Pioche district (Westgate, 1932:13-14). At the two latter localities faunas correlative with that from the Nopah formation have been found (Mason, Longwell, and Hazzard, 1936). Kirk (Knopf, 1918:31-32) reported Upper Cambrian rocks in the northern portion of the Inyo Mountains, California, but, judging from data recently obtained by the writer, the beds so reported are Middle Cambrian; Upper Cambrian may or may not be present.

ORDOVICIAN SYSTEM

In the Nopah-Resting Springs region Ordovician rocks are found in the Nopah Range on both its western and eastern sides. On the west side of the range, along the line of section F-F′, Ordovician beds crop out at the base of the mountain front, and the Eureka quartzite can be reached easily from the Shoshone-Pahrump road. To the southward the strike and dip of the beds carries them progressively higher so that 3 to 4 miles south of section F-F′ the Eureka quartzite and the Pogonip (?) dolomite form the summit of the range. On the eastern side, about 6 miles south of the northern end of the mountains, the Eureka quartzite, and the Ordovician beds both below and above, are well exposed along the edge of Pahrump Valley.

Pogonip (?) dolomite (Lower Ordovician)

Distribution: The Ordovician rocks between the base of the Eureka quartzite and the top of the Nopah formation form a pronounced yellowish-buff zone along the west front of the Nopah Range from the western end of section F-F′ to the mountain summit 3 or 4 miles to the southeast. They are likewise exposed on the eastern slope of the range 6 or 7 miles south of the northern end.

Lithology: The Lower Ordovician is easily recognizable below the Eureka quartzite, for it is characterized by the presence of considerable clastic material which commonly produces a yellowish-buff weathered surface. Along the line of section E-E′ the basal 25 to 40 feet of the formation consists of yellowish-buff-weathering, sandy and clayey dolomite which is locally cross-bedded or shaly and shows at its base a somewhat irregular contact with the underlying bed. This unit is followed by about 275 feet of light-gray to grayish-buff dolomite in the upper portion of which occurs reddish-brown chert in the form of rounded nodules, and thin, discontinuous sheets.

Clayey and sandy, buff- to reddish-brown-weathering dolomite, dolomitic sandstone, and dark-gray, clayey limestone follow. Locally the beds are quite sandy and shaly but no coarse clastic material was observed. This unit, which is about 345 feet thick, shows much lateral variation in lithology. South of section E-E′ it is mainly gray-weathering dolomite, to the northward the buff-colored beds are more prominent and the top and bottom of the member are sharply defined. A few poorly preserved fossils were collected from the basal 50 feet (Coll. P.B. 9C).

About 180 feet of medium-gray, indistinctly mottled dolomite form the next member in the upper portion of which are thin lenticular beds of brownish-weathering white sandstone. This is overlain by 200 feet of interbedded dolomite and sandstone which in lithologic character is more or less transitional into the Eureka quartzite, though it is distinctly a separate unit. The dolomite in the transition-beds, which forms about 75 per cent of the measured thickness, is light creamy-gray in color and in some places quite sandy. The sandstone is a locally cross-bedded, fine-grained, light-gray to nearly white rock which commonly weathers to a rusty-brown. In a few of the sandstone layers occur lenticular zones of breccia-like conglomerate containing angular pieces of gray dolomite, up to a foot in diameter, set in a sandy matrix. Along the west front of the Nopah Range west of section F-F′ the upper 150 feet of the transitional beds yielded a few fossils (Coll. P.B. 61 and 62). Near Sixmile Spring, about 8 miles northeast of the Nopah Range, a fossil collection was obtained from the transitional zone immediately below the Eureka (Coll. P. B. 52 and 52A).

Thickness: The Lower Ordovician beds were measured along the line of section E-E′ where a thickness of 1,040 feet was obtained.

Age and correlation: The fossil collection from the Lower Ordovician were examined by Edwin Kirk and G. A. Cooper. They report as follows:

"*Collection No. P.B. 9C:* From the basal 50 feet of member (9C) of the Lower Ordovician, approximately 350 feet above the base of the formation. *Locality* is on the western slope of the Nopah Range between a quarter and a half mile east of Upper Cambrian localities P.B. 8 and 8A. Collections were made on the south slope of the canyon from a buff- to reddish-weathering, sandy dolomite over 100 feet thick. Traces of an old trail and camp site can be found in the canyon at this point."

Hesperonomia sp.

"*Collections No. P.B. 61 and 62:* From upper 150 feet of member (9E) of the Lower Ordovician. *Locality* is on the west front of the Nopah Range just west of the western end of section F-F′.

Mitrospira longwelli Kirk
Receptaculities sp.

"*Collection No. P.B. 52:* From 30 to 50 feet below the Eureka quartzite. *Locality* is on the southwest slope of a small outlier capped with Eureka quartzite a quarter of a mile north of the Pahrump-Ash Meadows road, 2 miles northwest of Sixmile Spring. Sixmile Spring is on the western side of Pahrump Valley in the Furnace Creek quadrangle.

Euconia ? sp.
Liospira sp.
Ctenodonta sp.
Orthis sp.

"*Collection No. P.B. 52A:* From about 200 feet below the Eureka quartzite. *Locality* is the same as for Collection P.B. 52.

Maclurites sp.
Mitrospira longwelli Kirk"

Collection P.B. 9C is reported as "high Canadian" and Collections P.B. 52, 52A, 61, and 62 as "high Pogonip" (Chazyan). Since no plane of demarcation can as yet be drawn between the Canadian and Chazyan portions of the beds here described, the whole unit is assigned to the Lower Ordovician and correlated tentatively with the Pogonip limestone of the Eureka district, Nevada, which is there known to include beds of both Canadian and Chazyan age. For the present no definite correlation will be attempted with the Ordovician beds of the Inyo Range first described by Kirk (Knopf, 1918:32-36) and later revised by Phleger (1933). In the Ely Spring Range, west of Pioche,

Nevada, Westgate (pp. 14-15) has described two Ordovician formations below the Eureka quartzite. Lithologically and faunally there appears some similarity between them and the beds here discussed. It is probable that additional fossils from the Nopah Range will allow a definite correlation between the two regions. Noble (oral communication, 1936) reports that on the west side of Pyramid Peak, the beds below the Eureka quartzite are similar to those described here, and that on the west side of Death Valley the beds immediately below the Eureka quartzite are reddish in color and contain a large amount of coarse clastic material. From the stratigraphic position of the beds at both localities there can be little question but that they are correlative with the Nopah "Lower Ordovician."

Eureka quartzite (Middle Ordovician)

Distribution: The Eureka quartzite, named and described originally by Hague (1892:54-57) in the Eureka district, Nevada, and known to occur at many other places in the Great Basin region, crops out on both the western and eastern slopes of the northern portion of the Nopah Range. Because of its lithologic individuality, which makes it easily recognizable even when viewed from a distance, the quartzite can easily be traced from a point at the west base of the mountains a little north of the line of section F-F′ until it crosses the range summit 3 to 4 miles to the south. Crossing the range it continues in a southeasterly direction and passes under the alluvium of Pahrump Valley 7 or 8 miles south of the north end of the mountains.

Lithology: The basal 15 feet of the formation is made up of fine-grained, white to very light-gray, thin-bedded quartzite, in some places a quartzitic sandstone, in which occur thin, discontinuous layers and lenticular masses of light-gray sandy dolomite. The quartzite commonly weathers to a dark reddish-brown and the dolomite develops a similar color where the amount of sand admixture is high.

The main mass of the formation is composed of fine-grained, massive, blocky-weathering, vitreous quartzite ranging in color from white to pale pink. Poorly defined bedding planes, 2 inches to a foot apart, show on the weathered surface which is characteristically reddish- or yellowish-brown in color. Cross-bedding is developed locally but is rather uncommon. The uppermost 2 feet of the formation are platy quartzite containing thin gray dolomite lenses.

Thickness: As measured in the northern end of the Nopah Range the Eureka quartzite is 265 feet thick. This value corresponds closely with thicknesses reported by Kirk (1933:27-44) from other Great Basin localities. From a somewhat cursory examination of the central portion of the eastern slope of the Nopah Range it is believed that the Eureka thins rapidly southward. About 12 miles south of the northern end it appears to be less than 100 feet thick.

Age and correlation: From the above description it is apparent that three lithologic divisions can be recognized within the quartzite. It is possible that these correspond with the units of the tripartite subdivision found by Kirk (1933) to be present in the Eureka at many places within the Great Basin. If such an assumption is correct the lowest unit of the Eureka in the Nopah section belongs with the Chazyan

beds; the middle portion is the "true Eureka" of Middle Ordovician age; and the upper 2 feet of platy quartzite and dolomite have to be considered the basal bed of the Upper Ordovician, Ely Springs (?) dolomite. Definite evidence of this relation not being at hand, all three units of the Nopah "Eureka quartzite" have been grouped together and are here considered a single stratigraphic unit of Middle Ordovician age.

Though unfossiliferous in the Nopah Range the age of the Eureka quartzite is fixed by its relationship to Ordovician beds below and above from which fossil collections have been made. This relationship, in addition to the lithologic character of the unit, allows little question as to its being correlative with the Eureka quartzite of the Eureka district, Nevada.

The quartzite is known to crop out in regions closely adjoining the Nopah Range. The nearest occurrence is about 8 miles to the northeast on the west side of Pahrump Valley 2 miles northwest of Sixmile Spring. Nolan (1929, map) has mapped "Ordovician quartzite" in the northern portion of Spring Mountain, which is but a short distance from Sixmile Spring and Noble (oral communication, 1936) states that the Eureka occurs on the west slope of Pyramid Peak overlooking Death Valley east of Furnace Creek. Ball (1907, 29) has reported the quartzite present in both the Panamint and Amargosa Ranges.

Ely Springs (?) dolomite (Upper Ordovician)

Distribution: The beds here termed the Ely Springs (?) dolomite crop out as a distinctive dark-colored band above the Eureka quartzite. On the west slope of the northern end of the Nopah Range the formation is present at the valley level near the Shoshone-Pahrump road. To the south it rises progressively higher on the range front, crossing the summit ridge to the eastern slope about 3 miles south of section F-F′.

Lithology: The dolomite is a well-defined, somewhat massive-weathering unit which locally develops cliffed slopes above the Eureka quartzite. Predominantly dark smoky-gray dolomite in its lower portion, it becomes lighter gray toward the top. As a rule, individual beds 6 inches to 3 feet thick are well-defined where the rock is dark-gray, but become rather indistinct where it is lighter colored. Thinly bedded, platy weathering rock, which contains many small, black chert nodules and rusty-brown-weathering sandy zones, makes up the lower 50 feet of the formation. The rocks above are thicker bedded and more massive-weathering; in some layers brownish-weathering chert is abundant as small nodules or as thin layers parallel to the bedding. Along the line of section F-F′, lenticular zones of intraformational conglomerate two feet or more in thickness, are not uncommon. Dark-gray, angular to subangular dolomite pebbles and cobbles set in a lighter gray dolomitic matrix are their usual constituents. Fossils were collected from 50 to 75 feet above the base of the formation (Coll. P.B. 11Aa).

Thickness: Along the line of section F-F′ the Ely Springs (?) dolomite is 800 feet thick. At its type locality Westgate (p. 7) reports 675 feet of beds within the unit.

Age and correlation: Fossils collected from the lower portion of the Ely Springs (?) dolomite were examined by Edwin Kirk and G. A. Cooper who report as follows:

"*Collection No. P.B. 11Aa:* From 50 to 75 feet above the base of the Ely Springs (?) dolomite. *Locality* is on the west front of the northern Nopah Range along the line of section F-F′.

Zygospira sp.
Platystropia sp.
Dalmanella sp.
Rhynchotrema argenturbica White"

The forms listed above establish a Richmond (Upper Ordovician) age, as that term is used in the West, for the Ely Springs (?) dolomite. The beds are tentatively correlated with the Ely Springs dolomite described by Westgate (pp. 15-16) from the Ely Springs Range west of Pioche, Nevada, and referred to the Upper Ordovician. The formation is probably equivalent to the lower portion of the Lone Mountain limestone of the Eureka district, Nevada.

The presence of a very dark-gray dolomite immediately overlying the Eureka quartzite has been observed by the writer at several places in the southern Great Basin. Noble (oral communication, 1936) reports a dark-gray dolomite above the Eureka at Pyramid Peak and also in the Panamint Range. Longwell (written communication, Dec. 1936) has found a similar unit in the ranges north of Las Vegas, Nevada. At several places these beds have yielded Upper Ordovician fossils.

SILURIAN (?) SYSTEM

Between the top of the Ely Springs (?) dolomite and beneath the pre-Devonian surface of unconformity are 335 feet of dark- and light-gray dolomitic rocks which are here tentatively assigned to the Silurian. These beds, measured along the line of section F-F′, are cut out by unconformity and do not appear in section E-E′ 1¼ miles to the southward (see fig. 12). The lower 30 feet of the unit is characterized by reddish-brown-weathering, light-gray chert in discontinuous layers and lenses, which form at least 50 per cent of the rock mass. The amount of chert is less in the higher beds, and 200 feet above the base the dolomite is practically chert-free. The uppermost 90 feet of the member is light-gray dolomite in well-defined layers one to two feet thick. The lower beds in this zone contain thin layers of dolomite pebble conglomerate.

The Silurian (?) age here suggested is based upon a few poorly preserved fossils collected from the middle portion of the unit. These have been identified as probably *Syringopora* of Silurian (?) age. Lithologically the Silurian (?) beds resemble chert-rich, light-gray, fossiliferous dolomites of Silurian age found by Noble (oral communication, April 1936) at Pyramid Peak east of Furnace Creek. There the Silurian rocks follow dark smoky-gray dolomite which overlies the Eureka quartzite, a relation comparable to that holding in the Nopah Range.

A similar relationship is reported by Longwell (written communication, December 1936) in the ranges north of Las Vegas where thick-bedded, cream-colored dolomite of Silurian (?) age overlies dark dolomite of "Richmond" (Upper Ordovician) age.

Pre-Devonian unconformity

In the northern portion of the Nopah Range there is excellent physical evidence for an unconformity at the base of the Devonian. Between sections F-F′ and E-E′ over 300 feet of beds are cut out. Along section E-E′ the basal Devonian beds rest on Silurian (?) dolomite, 1¼ miles south the Silurian (?) rocks are not present and the Devonian directly overlies the Ely Springs (?) dolomite (Ordovician).

About 1,500 feet south of section E-E′ the pre-Devonian surface is exposed for a short distance along the strike. The surface of unconformity there developed on the Ely Springs (?) dolomite, shows a visible relief of from two to three feet over a horizontal distance of 15 to 20 feet. Locally, there occur pothole-like depressions as much as eight inches in depth. These are irregularly rounded to nearly circular in outline, and are separated by low, rounded ridges. The muddy dolomitic material of the basal Devonian beds filled these depressions and in many instances the laminations bend downward to conform with the irregularities of the old surface. Resting directly on the erosion surface and covered by the later, fine-grained material, are angular fragments of light-gray dolomite which have been partially cemented to form a thin, breccia-like layer. This material is present locally and, since none was found incorporated within the dolomitic mudstones above, it seems reasonable to assume that the "breccia" represents talus fragments developed and partially cemented to the old surface prior to the beginning of Devonian deposition.

Lithologic variation in the basal Devonian beds is apparent when they are followed along the strike. South of section E-E′ the material immediately overlying the surface of unconformity and for 15 to 20 feet above, is a fine-grained, brownish-gray, sandy and clayey dolomite which weathers to a yellowish-buff color. In part the rock has an irregular, shaly parting, but layers reach a maximum of one foot in thickness. Above the basal zone, fine-grained, light-gray dolomite contains much chert in the form of nodules and thin, discontinuous sheets. To the north toward section F-F′, the clayey character of the basal Devonian becomes less apparent, and cross-bedded sandy dolomite is more common.

From a faunal standpoint the presence of a break at the base of the Devonian is indicated by the apparent absence of a Lower Devonian unit. The lowest fauna found, about 50 feet above the plane of inconformity, is Middle (?) Devonian in age.

The presence of an unconformity at the base of the Devonian has been reported at other localities in the southern portion of the Great Basin region. It is known to occur in the Providence Mountains and its presence has been reported recently in the Goodsprings district, Nevada, (Hazzard and Mason, 1936B).

In the ranges north of Las Vegas, Nevada, Longwell (written communication, 1936) reports "some sedimentary evidence of a disconformity at the base of the Devonian." A zone or thin-bedded sandstone and limestone rich in fossils (lower Middle Devonian) rests on cream-colored dolomite of Silurian (?) age. The thin-bedded zone shows much variation in lithology. The amount of sandstone varies from range to range and the thickness is not uniform. The above

description fits very closely the conditions in the Nopah Range. Longwell notes, however, that he "did not recognize certainly an erosional unconformity at the base of the zone." Kirk's (Knopf, p. 34) statement relative to the base of the Devonian in the Inyo Mountains implies that no unconformity is present. Phleger (1933: 2 and 5) states definitely that at some places the uppermost Ordovician beds are conformably overlain by the basal Devonian quartzites, but he likewise notes that at other localities the Devonian rests "with apparent conformity" on beds lower in the Ordovician section. In view of these statements and in light of studies along the unconformity in the Nopah, Goodsprings, and Providence Mountain regions, the writer believes it probable that an unconformity is present at the base of the Devonian in the Inyo Mountains, and has so indicated on the correlation charts which accompany this report. The apparent absence of Silurian beds and the statement by Kirk (Knopf. p. 37) that the "affinities of the [Devonian] fauna seem to lie with the Middle rather than with the Lower Devonian" are points also worthy of consideration.

In the northern Great Basin area a pre-Devonian unconformity has been reported by Nolan (1933:18). As his statement summarizes the relations found in that general region, it is given below:

> "An unconformity at this point [between Silurian and Devonian] has not previously been reported from the Great Basin or adjacent regions, chiefly because sediments of either Silurian or Devonian age or both are commonly lacking. Both series have been reported from three localities in Utah and Nevada—the Randolph quadrangle, Utah, Pioche, Nevada, and Eureka, Nevada. In the Randolph quadrangle the succession is said to be apparently conformable; at Pioche the two are not in contact; and at Eureka the contact is gradational. It would thus appear that the unconformity in the Gold Hill quadrangle is local in extent, but it is perhaps significant that no late Silurian faunas have been reported from either Eureka or the Randolph quadrangle."

DEVONIAN SYSTEM

Sultan dolomite (Middle (?) Devonian)

Distribution: Devonian rocks are restricted to the northern few miles of the Nopah Range where they are present on both the western and eastern slopes. They are well exposed below the line of cliffs high on the western front, and are present beneath a similar series of cliffs, which face to the southwest about 5 miles south of the northern end of the range on the eastern side.

Lithology: The three somewhat poorly defined lithologic units within the Devonian have a combined thickness of 890 feet. They are grouped here as the Sultan dolomite.

The lower 230 feet of the formation is of somewhat variable lithology. Along the line of section F-F′ it is comprised of light creamy-gray dolomite; dolomite containing 25 to 50 per cent sand admixture; and reddish-brown-weathering, locally cross-bedded, fine-grained, white sandstone, in part sufficiently well cemented to be termed a quartzite. Approximately 750 feet north of the line of section, fossils were found about 50 feet above the base in brownish-weathering sandy dolomite (Coll. P.B. 113). In detail the section is as follows:

Top:		Feet
(G)	Creamy-gray dolomite in indistinct layers 4 to 5 feet thick	60
(F)	Light-gray dolomite with discontinuous lense-like layers of standstone which become fewer toward the top	35
(E)	Sandstone enclosing lenses of gray dolomite	15
(D)	Bluish-gray dolomite with sandstone interbeds	30
(C)	Reddish-brown to light-gray silicified sandy dolomite (zone of Coll. P.B. 113)	30
(B)	Light-gray dolomite	30
(A)	Cross-bedded sandy dolomite	10
		230

Above the basal unit is a very dark smoky-gray dolomite 110 feet thick, containing poorly preserved corals and gastropods (Coll. N.D. 10) and characterized in its middle portion by spaghetti-like white mottling and much chert, the latter in the form of irregular lenses and discontinuous layers a few inches in thickness. Thin lenses of dolomite-pebble conglomerate occur in the lower few feet. The basal contact is sharp though somewhat irregular along the strike; the top of the unit is rather indistinct. This member is tentatively correlated with the Ironside dolomite of Goodsprings, a unit described by Hewett (1931:14) as the lowest member of the Sultan limestone.

Above the Ironside (?) dolomite along section F-F′ the lower 200 feet of the 550-foot upper member of the Sultan dolomite has been sufficiently recrystallized to produce a light creamy-gray color throughout, and to make parting surfaces rather indistinct. Stratigraphically equivalent, unaltered beds are present about a mile south along the base of the high, nearly vertical cliffs just below the range crest. As these latter exposures were found difficult to reach, more accessible outcrops were examined on the eastern side of the range along section G-G′.

On the west side of the range 410 feet above the top of the Ironside (?) dolomite are two very dark smoky-gray to nearly black dolomite beds 10 to 15 feet thick separated by about 25 feet of light-gray limestone. These layers, here termed the "marker beds," are lithologically similar to the Ironside (?) dolomite below, and are characterized by the presence of many small, geode-like cavities lined or completely filled with dolomite in coarse, white crystals. On the eastern side of the mountains, along section G-G′, beds lithologically identical to those described above were found about 140 feet below the top of the Devonian; they were considered stratigraphically equivalent. It is possible that some error was introduced in making this assumption, but at the most it would amount to a relatively few feet.

In the vicinity of section G-G′ beds having a similar stratigraphic position to those recrystallized along section F-F′, on the west side of the range, comprise dark-gray dolomite in some places interbedded with or grading laterally into light-gray limestone. The dolomitic rock commonly occurs in layers ranging from six inches to two feet thick. Many of the beds contain white, coarsely crystalline dolomite as ramifying veinlets; as thick, irregular streaks, subparallel to the bedding; or as vug-like spots and irregular masses, some more than a foot in maximum dimension. Fossils were collected from these beds at various horizons between 140 and 270 feet below the top of the Devonian (Coll. P.B. G-3).

Above the dolomitic "marker beds" the remainder of the upper unit of the Sultan consists of dense, light-gray limestone in indistinct layers ranging from six inches to two feet thick, interbedded with, or grading laterally into light- and dark-gray dolomite. The dolomite beds commonly range from one to three feet thick. Locally a platy parting is developed where they are weathered.

About 20 feet below the top of the Sultan, the dark-gray, massive-weathering limestone contains many stromotoporoids. The topmost 15 feet of the formation is grayish-brown-weathering platy limestone which in its upper portion includes thin zones of limestone pebbles.

The top of the Devonian corresponds in a general way with the top of a rather indefinite zone, estimated to range from 100 to 200 feet in thickness, in which dolomitic rocks pass upward into predominantly calcic rocks. This change from limestone to dolomite seems to have more than local significance for it appears as a characteristic feature at or near the top of the Devonian not only in the Nopah Range, but also in the Providence Mountains and in the Goodsprings area. In these regions the Sultan (as here defined) and pre-Sultan carbonate rocks are dolomite or dolomitized limestone; the post-Sultan carbonate rocks of Paleozoic age are limestone in which only a small amount of dolomite occurs. This change in rock character finds topographic expression in the presence of nearly vertical limestone cliffs above steep slopes developed on the dolomite and partially dolomitized limestone.

Evidence is not at hand to definitely establish the relation at the Devonian-Mississippian boundary. An unconformity is suggested principally on the apparent absence of Upper Devonian beds. Longwell (1928:25) reports an unconformity (?) in the Muddy Mountains, Nevada, between the Muddy Peak limestone (Devonian) and the Rogers Spring limestone (Lower Mississippian). Kirk (Knopf, 1918: 38) makes no definite statement concerning the Devonian-Mississippian relation in the Inyo Mountains but he reports a "5-foot conglomerate bed" containing "rounded, limestone pebbles 5 inches or less in diameter." Additional work may show the presence of a pre-Mississippian unconformity.

Thickness: The Sultan dolomite in the Nopah Range is 890 feet thick. This is a composite figure derived from measurements taken along the sections F-F′ and G-G′. Due to some uncertainty as to correlation between the two sections the thickness may be in error by as much as 50 feet. In the type area Hewett (1931:14) reports 640 feet of beds in the thickest measured section of the Sultan limestone. To this figure must be added at least 100 feet of beds now known to be Devonian in age, which were originally placed within the Goodsprings dolomite (Hazzard and Mason, 1936b). Of the thickness so derived it is probable that at a maximum only the lower 300 feet of beds is of Devonian age; the major part of the Valentine and all the Crystal Pass member of the Sultan probably pertain to the Mississippian.

Age and correlation: Fossils are not common in the Sultan dolomite but sufficient were found to establish the Middle (?) Devonian age of the formation. Reports on the collections follow:

"*Collection No. P.B. 113:* From about 50 feet above the base of member (A) of the Sultan dolomite. *Locality* is on the western side of the Nopah Range approximately 750 feet north of section F-F′ and roughly a third of a mile east of its western end. (Report by Edwin Kirk and G. A. Cooper).

Tentaculites sp.
Spirifer cf. *argentarius* Meek

"The latter form is commonly reported from the Devonian of central Nevada. The faunule is undoubtedly Devonian, probably Middle.

"*Collection No. N.D. 10:* From Ironside (?) dolomite member (B) of the Sultan dolomite. *Locality* is along the line of section F-F′ on the west side of the Nopah Range near its northern end. (Report by J. F. Mason and Brooks Knight).

Cladopora sp.
Aulopora sp.
Syringopora sp.
Euomphalus sp.
Spirorbis sp.

"Because of poor preservation of material the above identifications are somewhat tentative. They clearly indicate, however, an undoubted Devonian age and are more probably Middle than Upper Devonian.

"*Collection No. P.B. G-2:* From the upper member (C) of the Sultan dolomite between 140 and 270 feet below the top of the formation. *Locality* is at the west end of section G-G′ on the eastern side of the Nopah Range about 5 miles south of the northern end. (Report by Edwin Kirk and G. A. Cooper).

Atrypa sp. (finely striate)
Stromotopora

"These forms indicate a Devonian age."

The application of the term "Sultan dolomite" to the Devonian rocks of the Nopah Range implies correlation with the formation of the same name at Goodsprings, Nevada, where the term was first used by Hewett (1931:13-16) to include all beds of supposed Devonian age. However, it is now known that not all the Devonian rocks present at Goodsprings were included within the Sultan (Hazzard and Mason, 1936b) and it seems probable that the upper portion of the unit, as there defined, is of Mississippian age. As described near Goodsprings, the formation embraces not only lithologic and faunal units comparable with those of the Nopah Devonian section, but also rocks lithologically similar to the major portion of the Mississippian Stewart Valley limestone.

Faunal evidence for the Mississippian age of the beds (Stewart Valley limestone) above the Sultan dolomite in the Nopah Range is excellent. At Goodsprings the faunal control is rather poor. Forms reported from the Ironside dolomite and the overlying 100-foot zone appear comparable with the Nopah Devonian forms; those collected from the Valentine limestone member of the formation ("zone 100 to 300 feet above the Ironside dolomite member") suggest a Mississippian rather than Devonian age. The writer believes that further study will show the validity of the Mississippian age here suggested for the upper portion of the original Sultan limestone.

Correlation of the Sultan dolomite with Devonian units reported at many localities in southeastern California and southern Nevada will not yet be attempted. In the Providence Mountains, California, Middle (?) Devonian rocks are present and the section is very similar, both lithologically and faunally to that at Goodsprings. In the Inyo Range Kirk (Knopf, 1918:36-37) reported 1,500 feet of beds of Middle (?) Devonian age.

MISSISSIPPIAN SYSTEM

Rocks of Mississippian age occur only in the northern portion of the Nopah Range. Two formations are recognized, the Stewart Valley limestone at the base, and the Monte Cristo (?) limestone above. It is possible that the formations, as here defined, represent different epochs of Mississippian time, but evidence is not yet sufficient to warrant smaller division.

Stewart Valley limestone

Distribution: The beds for which the name Stewart Valley limestone is here proposed, are present on both the western and eastern slopes of the Nopah Range. They crop out to the east of the Devonian rocks and form the major portion of the cliffs which are present along the northern range summit within the area enclosed by the 5,000-foot contour line. On the western slope the northern limit of outcrop is about the eastern end of section F-F′. The name is taken from Stewart Valley which adjoins the Nopah Range on the north.

Lithology: Three members are recognized within the Stewart Valley limestone. The lowest of these, about 690 feet thick, is predominantly light- to dark-gray limestone in beds averaging one to five feet in thickness, with some massive layers as much as 10 feet thick. The basal few feet of the unit comprise reddish-brown, pebbly, limy sandstone and buff dolomite. Thin beds of similar sandstone and dolomite are occasionally present above the base. As a rule the sandy zones form narrow benches within the vertical to near-vertical cliffs characteristically developed by the unit as a whole.

The following section of the lowest member of the Stewart Valley limestone, measured along section G-G′, is characteristic of the unit in the Nopah Range:

Top:		Feet
(A)	(p) Dark-gray, locally cherty limestone, in layers 6 inches to 3 feet thick	270
	(o) Dark-gray locally dolomitized limestone in beds 6 inches to 4 feet thick. In the upper 100 feet four reddish-brown, limy sandstone beds ranging from 1 to 5 feet in thickness occur. Some of the sandstone contains small, light-gray limestone pebbles	200
	(n) Intraformational pebble to cobble conglomerate formed of subangular to rounded or flat fragments of gray limestone. Cobbles average between 6 and 8 inches in maximum dimension; most of the material is of pebble size. One block over 7 feet long was observed. Unit forms a distinct bench between nearly vertical cliffs	35
	(m) Massive, light-gray limestone in beds ranging from 1 to 10 feet thick	30
	(l) Brownish-weathering, light-gray, fine-grained limy sandstone	3
	(k) Massive, light-gray limestone in beds ranging from 1 to 10 feet thick. Basal 5 feet dark-gray	35
	(j) Brownish-weathering, light-gray, fine-grained limy sandstone which lenses out along the strike within a few hundred feet	3
	(i) Platy, light-gray limestone; bench-forming	5
	(h) Light- to medium-gray limestone in beds from 1 to 5 feet thick	46
	(g) Reddish-brown-weathering, brown to yellowish-brown, fine-grained limy sandstone showing current cross-bedding and "cut and-fill" features at base	15
	(f) Massive dark-gray limestone with corals (Coll: P.B. G-5)	25
	(e) Massive, medium-gray limestone	5
	(d) Brownish-weathering, light-gray sandstone. The basal few feet contain gray limestone pebbles up to half an inch in diameter. The sandstone is not of constant thickness and includes lenticular gray limestone layers up to 1 foot in thickness	10
	(c) Massive light-gray limestone	3
	(b) Reddish-brown-weathering, light-gray limy sandstone with small limestone pebbles sporadically distributed throughout	3
	(a) Dense, buff-weathering gray dolomite	2
		690

The above described member is not sharply set off from the unit above, but grades into it through a transitional zone of interbedded dark-gray and light creamy-gray limestone. In measuring, the top was placed at the lowest creamy-gray bed.

The middle member of the Stewart Valley limestone, 240 feet in thickness, is exposed only on the eastern slopes of the mountains where is it readily accessible along the line of section G-G′. It is easily distinguishable from the units both below and above because of the characteristic light creamy-gray color and dense porcelain-like texture of its rocks. Bedding is rather indistinct and individual layers average between one and two feet in thickness; a few beds when weathered yield platy fragments, one to three inches thick; others weather to a light buff-color. Chert does not occur, and no fossils were found. Lithologically, the rock is very similar to the Crystal Pass limestone described by Hewett (1931:15) at Goodsprings and there assigned to the Devonian.

The basal 50 feet of the member include dark-gray limestone layers interbedded with light-gray rocks. Similarly, the upper 100 feet contain interbeds of dark-gray limestone which increase in number toward the top. The upper limit was taken at the topmost light-gray layer.

Along the line of section G-G′ approximately 250 feet of fossiliferous rocks comprise the highest member of the Stewart Valley limestone. The unit as a whole is very dark-gray in color, in striking contrast to the light-gray of the underlying beds. The lowest 50 feet is fossiliferous (Coll. P.B. G-12) dark-gray dolomite in beds one to two feet thick. This is followed by an equal thickness of very dark-gray, irregularly and indistinctly bedded limestone, which contains much brown chert in nodules and thin irregular sheets. The rock is fossiliferous, corals being especially common (Coll. P.B. G-12A). The upper 150 feet, more or less lithologically similar to the lower portion, comprises dark-gray, irregularly-bedded limestone in layers ranging from six inches to two feet in thickness. At some localities, immediately below the top of the unit, the bedding is very poorly defined, and the rock contains much broken coral and many small, pebble-like chert fragments. Fossils were collected from the topmost 10 feet (Coll. P.B. H-2).

Thickness: The Stewart Valley limestone, as measured along section G-G′ is 1,180 feet thick.

Age and correlation: A Mississippian age is established for the Stewart Valley limestone by fossil collections obtained in both basal and topmost portions of the formation. Edwin Kirk and G. A. Cooper report on these collections as follows:

"*Collection No. P.B. G-5:* From about 25 feet above the base of the Stewart Valley limestone. *Locality* is on the eastern side of the Nopah Range along section G-G′ very near its western end. Material poorly preserved. Corals and *Stromotopora* possibly of Mississippian age.

"*Collection No. P.B. G-12 and 12A:* From the basal 100 feet of the upper member of the Stewart Valley limestone; from 150 to 250 feet below the top of the formation. *Locality* is on the eastern side of the Nopah Range along section G-G′.

Lonsdaleia sp.
Zaphrentis sp.
Spiriferina sp.
Athyris sp.
Schizophoria sp.

"*Collection No. P.B. H-2:* From the topmost 10 feet of the Stewart Valley limestone. *Locality* is on the eastern side of the Nopah Range along section G-G'.

Zaphrentis sp.
Athyris sp.

"Collection G-12, G-12A, and H-2 are definitely Mississippian in age."

The formation is believed to be partially equivalent to the upper portion of the Valentine limestone and the Crystal Pass limestone at Goodsprings, which, as has been pointed out, are probably Mississippian rather than Devonian in age. If the lower and middle members of the Stewart Valley limestone are comparable with the upper portion of the Valentine and the Crystal Pass limestone, respectively, there is a definitely thicker "Valentine" unit in the Nopah section as well as a thinner "Crystal Pass" unit. The total thickness of the upper Valentine limestone, about 280 feet, maximum) and the Crystal Pass limestone (260 feet) is much less than the combined thickness of the lower (690 feet) and the middle (240 feet) members of the Stewart Valley limestone. The upper member of the Stewart Valley does not appear to be represented at Goodsprings, nor is it known in the Providence Mountains where the section is very similar to that at Goodsprings.

The reasons for giving a new name to the lower portion of the Mississippian section rather than extending the term "Monte Cristo limestone" given by Hewett (1931:17) at Goodsprings are three-fold, (1) the Stewart Valley and Monte Cristo (?) limestones, as delineated in the Nopah Range, are definite cartographic units on basis of lithology, (2) a definite break, probably of unconformable character, but of unknown stratigraphic value at present, is believed to exist between the two formations, and (3) the faunal assemblages, admittedly very incomplete, suggest that the two formations may belong to different epochs of the Mississippian. As originally defined, the Monte Cristo limestone was "made to include all Mississippian rocks in the Goodsprings quadrangle."

Unconformity at the top of the Stewart Valley limestone: Evidence that an unconformity is present at the top of the Stewart Valley limestone is not as yet conclusive; final proof must await additional information from regions closely adjoining. Several facts pointing to its presence are summarized below: (1) The lithologic change at the contact between the Stewart Valley and Monte Cristo (?) beds in the Nopah section. The topmost Stewart Valley is a fossiliferous dark-gray limestone; the basal Monte Cristo (?) is a platy, siliceous shale which passes rather abruptly upward into black to brown well-bedded chert followed by cherty limestone. (2) The presence of a 12-foot cobble-bearing sandstone in the Providence Mountains at the base of beds equivalent to the Monte Cristo limestone. There the sandstone rests on a well-defined erosion surface cut into a creamy-gray limestone lithologically similar to both the Crystal Pass member of the Sultan limestone at Goodsprings, and to the middle member of the Stewart Valley limestone in the Nopah Range. (3) Presence of the fossiliferous upper member of the Stewart Valley limestone in the Nopah Range and the absence of a similar unit at both Goodsprings and in the Providence Mountains.

Monte Cristo (?) limestone (Mississippian)

Distribution: Rocks belonging to the Monte Cristo (?) limestone crop out to a limited extent along the northern summits of the Nopah Range. There the brownish-weathering cherty beds at the base of the formation make up a part of the ridge north of summit 5,600. These beds, as well as those overlying, are present on the eastern slope of the mountains and in the general vicinity of sections G-G′ and H-H′ are well exposed in the foothills bordering Pahrump Valley. North of these sections the Mississippian, Pennsylvanian, and probably the Devonian rocks are involved in the folding and overthrusting. Locally, the upper portion of the Mississippian section is overturned and thrust over the Pennsylvanian beds (fig. 15). The top of the Mississippian is nowhere exposed in the Nopah Range.

Lithology: Two lithologic members are recognizable within the formation. The boundary between them is gradational, and it probably does not occupy the same stratigraphic position along the strike. The lower member, 472 feet in thickness, is predominantly limestone; in detail its lithologic character is quite variable along the strike. Viewed from a distance, the unit has an average dark color due to the presence of dark-brown-weathering chert in distinct beds and in irregular sheets and nodules. The upper and lower limits of many of the cherty horizons are irregular, though the units themselves are more or less continuous along the strike; especially is this true in the lower portion of the member. Some of the beds low in chert content become practically chert-free at places. At the base is a thin gray to greenish, platy shale which rests on the Stewart Valley limestone. As a whole the member tends to develop step-like slopes with low cliffs separated by steeply inclined benches.

The upper member of the Monte Cristo (?) limestone, estimated to have a minimum exposed thickness of about 515 feet, comprises indistinctly bedded, massive weathering, light-gray limestone which is characteristically cliff-forming. In part the rock is crinoidal; locally it is dolomitized. Chert-rich beds, similar in character to those occurring in the lower member of the formation, are present in minor number.

The upper portion of section G-G′ and section H-H′ which are about half a mile apart, together include the complete Monte Cristo (?) sequence exposed in the Nopah Range. They are combined and summarized below. In the vicinity of section H-H′, beds stratigraphically comparable to the upper portion of section G-G′, are present but as they are difficult of access they were not measured.

Top:

(Top of Mississippian not exposed.)

Monte Cristo (?) formation:

(Top of section H-H′)

			Feet
(2) Upper member			
	(F)	Light-gray, coarsely crystalline crinoidal limestone. Lower 50 feet obscurely bedded and massive-weathering. Upper portion shows better defined parting planes: in part marked by thin chert sheets and chert nodules. Minimum estimated thickness	200
	(E)	Cherty, gray limestone which in part weathers brown. Chert occurs as irregular, lenticular to nodular, masses. Bedding is poorly defined. Minor dolomitization	130
	(D)	Massive, indistinctly bedded, light-gray, coarsely crystalling, crinoidal limestone. Upper portion dark-gray. Minor amount of chert	185
		(Base of section H-H′; top of section G-G′.)	
(1) Lower member			
	(C) (c)	Gray limestone with interbedded brownish-weathering chert. Limestone-chert ratio about 1:1	50
	(b)	Light-gray, chert-free limestone in massive bed	25
	(a)	Coarsely crystalline, medium-gray limestone in beds averaging 1 foot thick. Some brownish chert (Coll. P.B. H-5)	66
	(B) (b)	Interbedded gray limestone and brownish-weathering chert. The latter occurs in thin, fairly continuous sheets and as thin, sheet-like lenses ranging from one-fourth to 6 inches thick. Limestone-chert ratio averages about 3:1; in the upper 25 feet the ratio is about 1:1. The unit is cliff-forming. From a distance the brown color of the chert is predominant and the whole cliff-front appears brown	153
	(a)	Interbedded gray limestone and gray, brownish-weathering chert. Both chert and limestone occur in thin, continuous beds. In the basal portion the limestone is commonly lenticular. Limestone chert ratio ranges from about 3:1 in the basal portion to 1:1 near the top	121
	(A) (b)	Dark-gray- to dark-reddish-brown-weathering black chert in irregular to lenticular beds ranging from one-fourth to 4 inches in thickness. Locally, the chert is light-gray to nearly white and shows narrow, irregular, black color-bands. Thin, siliceous shale layers occur in the basal few feet. The upper 25 feet include 2 to 3 per cent light-gray limestone in thin lenticular layers	45
	(a)	Dark-gray to greenish siliceous shale which breaks into thin, platy fragments. Black chert occurs sporadically as thin lenses and nodules up to 1 inch thick. Upper limit of the shales is sharp against the overlaying bedded cherts; lower limits is talus covered and contact surface with the Stewart Valley limestone is not visible	12
			987+

Thickness: It was not possible to obtain a continuous and unbroken section of the Monte Cristo (?) limestone for measurement. The thickness of 987+ feet reported is a composite measurement of the upper portion of section G-G′ and section H-H′: the maximum thickness of the whole formation is not known. Due to lateral variation in lithology the matching of sections was only approximate. The error so introduced is probably not greater than 50 ± feet. In the Goodsprings quadrangle the Monte Cristo limestone has a maximum thickness of 1,240 feet.

Age and correlation: Fossils found in the Monte Cristo (?) limestone were examined by Mason who reports as follows:

"*Collection No. P.B. H-5:* From a fossiliferous zone approximately 330 feet above the base of the Monte Cristo (?) limestone. *Locality* is along the line of section G-G′ on the northeast slope of the Nopah Range.

Reticularia sp.
Athyris cf. *lamellosa* Leveille
Leptaena sp.
Dictyoclostus burlingtonensis (Hall)
Marginifera sp.
Spirifer aff. *keokuk* Hall
Spirifer cf. *grimesi* Hall
Spiriferella sp.
Rhynchotreta sp.

"Similar forms are reported by Hewett from the Dawn and Anchor members of the Monte Cristo limestone in Goodsprings quadrangle. The age is comparable to that of the Osage group lower Middle Mississippian."

On the basis of the above the Monte Cristo (?) limestone is assigned to the Mississippian and is tentatively correlated with the formation of the same name at Goodsprings. No definite correlation can yet be made between the two members of the Nopah section and the five lithologic members described by Hewett (1931:17-18). Stratigraphic position and lithologic similarity suggest that the lower member may be equal approximately to the Dawn and Anchor limestones, and the upper member to the Bullion dolomite. More precise correlation with the Goodspring section and with Mississippian rocks at other localities in the southern portion of the Great Basin must await more complete faunal and stratigraphic data.

PENNSYLVANIAN SYSTEM

Bird Springs (?) formation

Distribution: The rocks here termed the Bird Springs (?) formation are exposed over an area estimated at about half a square mile, on the eastern side of the Nopah Range 3 to 3½ miles south of the northern end. The eastern limit of outcrop is the base of the mountain front; the western limit is a thrust fault which brings the Mississippian beds over the Pennsylvanian rocks. Neither base nor top of the formation were found.

Lithology: The lower 150 feet of the exposed section consist of light- to dark-gray, dense, porcelainlike, partially dolomitized limestone weathering into massive layers one to four feet thick. Commonly present but sporadically distributed are rounded to lenticular black chert nodules ranging up to six inches in diameter. Platy and shaly, locally reddish-weathering, fine-grained limestone in bands two to three feet thick separates the more massive layers. Within the upper 50 feet of the lower unit a group of beds, totaling from five to 10 feet in thickness, weathers to a pronounced yellowish-buff color, locally forming an excellent marker horizon.

The 630+ feet of limestone which form the major portion of the formation comprises groups of beds which weather as single, massive, cliff-forming units from 10 to 30 feet thick, and thinly layered, shaly to platy rock in zones of comparable thickness. The massive-weathering rocks alternate with the thinly layered beds to produce a very definite series of low cliffs separated by gently sloping benches (fig. 15).

As a rule, the cliff-forming units are made up of dark- to light-gray cherty limestone. Chert is most common low in the section, where it appears as thin, irregular sheets, and as irregular nodules and lenses arranged parallel to the bedding; from a distance, an appearance of continuous chert layers is thus produced. The thinly layered to platy bench-forming limestones are dolomitized in some places, and many of the beds weather to a pale reddish or buff color. Sandy limestone in yellowish-weathering layers occurs near the top of the section. Much of the rock within the formation gives a fetid odor when broken.

Thickness: The 780 + feet here reported for the Bird Springs (?) unit along the line of section I-I′ is a minimum, for neither the base nor summit are exposed. From the Goodsprings quadrangle Hewett records a maximum thickness of 2,500 feet in the Bird Springs formation.

Age and correlation: A Lower Pennsylvanian age is established for the Bird Springs (?) beds by two fossil collections made within the upper 150 feet of the formation. Mason reports as follows:

"*Collection No. P.B. 154:* From a fossiliferous zone about 100 feet below the top of the Bird Springs (?) formation. *Locality* is on the northeast side of the Nopah Range about half a mile northeast of the north end of section I-I′ (fig. 13) on low ridge extending into Pahrump Valley.

Ramose bryozoans
Chonetes granulifera Owen var.
Composita cf. *ovata* Mather
Dictyoclostus sp.
Linoproductus sp.
Marginifera muricatina Dunbar and Condra
Neospirifer triplicatus (Hall)
Spirifer cf. *occidentalis* Dunbar and Condra

"This assemblage is reported by Hewett from between 450 and 1,000 feet above the base of the Bird Springs formation at Goodsprings. The age is Lower Pennsylvanian (Des Moines).

"*Collection No. P.B. 125:* From fossiliferous zone about 50 feet stratigraphically below the horizon of Collection P.B. 154. *Locality* is same as P. B. 154.

Solitary corals
Ramose and fenestellid bryozoans
Composita cf. *subtilita* (Hall)
Derbya crassa (Meek and Hayden)
Linoproductus sp.
Marginifera muricatina Dunbar and Condra
Neospirifer aff. *triplicatus* (Hall)
Punctospirifer sp.

"This assemblage is of the same age as that listed above."

On basis of Mason's report the Bird Springs (?) formation is assigned to the Lower Pennsylvanian and is correlated tentatively with the lower 1,000 feet of the Bird Springs formation of the Goodsprings quadrangle (Hewett, 1931:21-30). In the type area the upper beds of the formation are undoubtedly of Permian age, for in the Las Vegas quadrangle, which lies just north of the Goodsprings quadrangle, Longwell and Dunbar (1935) have found Permian fusulinids in the upper 2,900 feet of the 5,000-foot Bird Springs formation. In the Providence Mountains, California, both Pennsylvanian and Permian are known to be present within a series of beds both lithologically and stratigraphically comparable with the Bird Springs formation of the Goodsprings area. At present no correlation can be attempted with Pennsylvanian units reported at other localities in the southern Great Basin region.

LITERATURE CITED

ANDERSON, GEORGE H.
1937a. Petrology and structure of the Northern Inyo Range (*abstract*): Geol. Soc. America, Proc., 1936.
1937b. Pre-Cambrian stratigraphy in the Northern Inyo Range (*abstract*): Geol. Soc. America, Proc., 1936.

BALL, SYDNEY H.
1907. A geologic reconnaissance in southwestern Nevada and eastern California: U. S. Geol. Surv., Bull. 208.

GLOCK, WALDO S.
1929. Geology of the east-central part of the Spring Mountain Range, Nevada: Am. Jour. Sci., 5th. ser., vol. 17, pp. 326-341.

HAGUE, ARNOLD.
1892. Geology of the Eureka district, Nevada: U. S. Geol. Surv., Mon. 20.

HAZZARD, JOHN C.
1933. Notes on the Cambrian rocks of the eastern Mohave desert, California, with a paleontological report by Colin H. Crickmay: Univ. Calif. Pub., Bull. Dept. Geol. Sci., vol. 23, no. 2, pp. 57-70.

HAZZARD, JOHN C., and MASON, JOHN F.
1936a. Middle Cambrian formations of Providence and Marble Mountains, California: Geol. Soc. America Bull., vol. 47, pp. 229-240.

1936b. "Goodsprings Dolomite" of Nevada and its faunas (*abstract*): Geol. Soc. America, Proc., 1935, p. 378.

HEWETT, DONNEL F.

1928. Late Tertiary thrust faults in the Mojave desert, California: Nat. Acad. Sci., Proc., vol. 14, no. 1, pp. 7-12.

1931. Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Surv., Prof. Paper 162.

KIRK, EDWIN.

1933. The Eureka quartzite of the Great Basin region: Am. Jour. Sci., 5th. ser., vol. 26, pp. 27-44.

KNOPF, ADOLPH.

1918. A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada: U. S. Geol. Surv., Prof. Paper 110.

LONGWELL, CHESTER R.

1926. Structural studies in southern Nevada: Geol. Soc. Am. Bull., vol. 37, pp. 551-584.

1928. Geology of the Muddy Mountains, Nevada: U. S. Geol. Surv., Bull. 798.

LONGWELL, CHESTER R., and DUNBAR, CARL O.

1936. Pennsylvanian-Permian boundary in southern Nevada (*abstract*): Geol. Soc. America, Proc., 1935, p. 374.

MASON, JOHN F.

1935. Fauna of the Cambrian Cadiz formation, Marble Mountains, California: So. Calif. Acad. Sci. Bull., vol. 34, pt. 2, pp. 97-119.

MASON, JOHN F., LONGWELL, CHESTER R., and HAZZARD, JOHN C.

1937. Sequence of Cambrian faunas in the southern Great Basin (*abstract*): Geol. Soc. America, Proc., 1936.

MAXSON, JOHN H.

1934. Pre-Cambric stratigraphy of the Inyo Range (*abstract*): Pan-Am. Geologist, vol. 61, no. 4, pp. 310-311.

NOBLE, LEVI F.

1922. (and MANSFIELD, G. R., and others). Nitrate deposits in the Amargosa region, Southeastern California: U. S. Geol. Surv., Bull. 724.

1926. Notes on a colemanite deposit near Shoshone, California, with a sketch of the geology of a part of Amargosa Valley: U. S. Geol. Surv., Bull. 785, pp. 66-73.

1934. Rock formations of Death Valley, California: Science, n.s., vol. 80, no. 2069, pp. 173-178.

NOLAN, THOMAS B.

1929. Notes on the stratigraphy and structure of the northwest portion of Spring Mountain, Nevada: Am. Jour. Sci., 5th. ser., vol. 17, pp. 461-472.

1935. The Gold Hill Mining district, Utah: U. S. Geol. Surv., Prof. Paper 177.

PHLEGAR, FRED B.

1933. Notes on certain Ordovician faunas of the Inyo Mountains, California: So. Calif. Acad. Sci. Bull., vol. 32, pt. 1, pp. 1-21.

SMITH, JAMES PERRIN.

1916. Geological Map of the State of California: Issued by the state Mining Bureau under the direction of Fletcher Hamilton.

SPURR, JOSIAH E.

1903. Descriptive geology of Nevada south of the fortieth parallel, and adjacent portions of California: U. S. Geol. Surv., Bull. 208.

1906. Ore deposits of the Silver Peak quadrangle, Nevada: U. S. Geol. Surv., Prof. Paper 55.

TUCKER, W. BURLING.

1921. Los Angeles Field Division: Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Ventura Counties: Calif. State Min. Bureau, Mining in California, State Mineralogist's Report 17.

TURNER, HENRY W.

1909. Contribution to the geology of the Silver Peak quadrangle, Nevada: Geol. Soc. America Bull., vol. 20, pp. 223-264.

WALCOTT, CHARLES D.

1886. Cambrian faunas of North America: U. S. Geol. Surv., Bull. 30.

1891. Correlation papers: Cambrian: U. S. Geol. Surv., Bull. 81.

1908. Cambrian geology and paleontology: no. 5. Cambrian section of the Cordilleran area: Smithsonian Misc. Coll., vol. 53, no. 1812. pp. 188-189.

1912. Cambrian Brachiopoda: U. S. Geol. Surv., Mon. 51.

1915. The Cambrian and its problems in the Cordilleran Regions *In* Problems of American Geology, pp. 162-233, New Haven.

WESTGATE, LEWIS G., *In* WESTGATE, L. G., and KNOPF, ADOLPH.

1932. Geology and ore deposits of the Pioche District, Nevada: Part 1. General geology, by WESTGATE, L. G., U. S. Geol. Surv., Prof. Paper 171.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

NATIVE ARSENIC FROM GRASS VALLEY, CALIFORNIA[1]

By W. D. JOHNSTON, JR.[2]

Native arsenic has recently been found on the north end of the 1,600-foot level of the Empire Mine, Grass Valley. A gray metallic boytroidal mass approximately 1½ x 1½ x 2 inches in size was received from Mr. Fred Searls, of the Newmont Company. The specimen was composed wholly of native arsenic except for a few euhedral quartz crystals enclosed in it. Chemical tests for antimony, bismuth, iron and silver were negative.

F. W. Nobs, superintendent of the Empire-Star group, kindly furnished the following note on the locality: "* * * The vein here is quartz in diabase country, both footwall and hanging wall. The immediate region is traversed by several crossings which carry white iron pyrite. Most interesting to me is the occurrence of 'highgrade' or free gold ore associated with pyrite and arsenopyrite in this same stope. The botryoidal mineral is rare. As far as I know, only half a dozen pieces about the size of the one sent you were noted. I have a lump that has fine soft free gold within the arsenic."

The 1,600-foot level is approximately 650 feet vertically below the collar of the Empire shaft and 500 feet below Wolf Creek. While this depth does not preclude the possibility that the arsenic may be supergene, neither does it establish its secondary origin.

[1] An excerpt from "The gold-quartz veins of Grass Valley, Calif.," Geological Survey Professional Paper (in preparation). Published by permission of the Director, Geological Survey, United States Department of the Interior.

[2] Geologist, U. S. Geological Survey.

ADMINISTRATIVE

Personnel.

There have been no changes of personnel in the Division of Mines to be noted the past three months.

New Publications.

The new GEOLOGIC MAP OF CALIFORNIA has been sent to the lithographer, and Bulletins 113 and 115, "Minerals of California," and Bibliography of California Geology and Mineral Resources, 1931-1936, inc.," respectively, to the state printer. These publications should be ready for distribution early in the new year.

COMMERCIAL MINERAL NOTES (Nos. 172-174, inc.) August, September, October, 1937, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'CALIFORNIA JOURNAL OF MINES AND GEOLOGY.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Library

HENRY H. SYMONS, Statistician and Curator

Tabulations are presented herein showing the complete totals for all substances produced in California during the year 1936, grouped by substances and by counties. The complete detailed annual report on the mineral production of California for 1936 will be available later as Bulletin 114 of the State Division of Mines.

SUMMARY—1936

The total value of the mineral output of California for the year 1936 was $327,804,268, being an increase of $64,399,951 over the total of 1935 which was $263,404,317. There were fifty-eight different mineral substances, exclusive of a segregation of the various stones grouped under gems; and all fifty-eight counties of the state contributed to the list.

As revealed by the data following, the salient features of 1936 compared with the previous year, were: All groups such as fuels, metals, structural material, industrial minerals, and salines show a marked increase in total value. Of the individual mineral products petroleum showed the greatest increase in value and output followed in turn by miscellaneous stone, cement, gold, borates, potash, natural gas, silver, brick and hollow building tile, soapstone and talc, granite, silica. While those showing decreases in total value were coal, chromite, mineral water, salt, sandstone.

Of the fuels, petroleum showed an increase in value of $32,331,874 and an increase in amount from 205,979,855 barrels to 214,776,227 barrels of crude oil. The average price received for all grades of crude oil was an increase over that received in 1935. Natural gas showed an increase in value with a slight decrease in amount from 302,447,193 M cu. ft. worth $17,680,661 to 298,922,708 M cu. ft. valued at $18,585,970.

Of the metals, the gold output increased from 890,430 fine ounces to 1,077,442 fine ounces and in value from $31,165,050 to $37,710,470. Silver increased from 1,191,112 fine ounces worth $856,112 to 2,103,799 fine ounces worth $1,629,392; copper from 2,031,836 lbs. worth $168,645 to 9,991,799 lbs. worth $919,245, with quicksilver, lead, tungsten, and iron also showing increased value, zinc and chromite being the only metals to show decreased values.

Of the structural materials; cement increased in amount and value from 8,086,292 barrels worth $10,120,721 to 13,300,188 barrels worth $18,314,589, miscellaneous stone from a total value of $5,571,041 to $16,575,238; brick and hollow building tile from a value of $1,855,343 to $2,240,905. Increases were also registered by granite, lime, marble (onyx and travertine), and slate. Magnesite and sandstone showed decreases in value.

In the industrial group, the total value increased from $4,618,588 to $5,236,534 and with most of the important mineral products therein showing increases, noteworthy were pumice and volcanic ash, silica, talc and soapstone. Decreases were registered by barite, mineral water, and pyrite.

The total value of the saline group increased from $9,700,802 to $12,416,349 with all the important products showing an increased value with the exception of salt.

The distribution of the 1936 output of California by substance is shown in the following tabulation:

Substance	Amount	Value	Number of producers
Bentonite	10,185 tons	$165,131	7
Borates	313,389 tons	5,911,093	5
Brick and hollow building tile		2,240,905	45
Cement	13,300,188 bbls.	18,314,589	10
Chromite	221 tons	3,314	4
Clay, pottery	382,823 tons	646,920	49
Coal	370 tons	1,815	3
Copper	9,991,799 lbs.	919,245	E5
Feldspar	3,430 tons	24,959	4
Gems		2,878	12
Gold	1,077,442 fine ozs.	37,710,470	(A)
Granite		244,243	20
Gypsum	143,549 tons	282,703	6
Lead	1,098,545 lbs.	50,533	C14
Lime	64,275 tons	633,678	21
Limestone	295,792 tons	661,757	
Magnesium salts	7,595,647 lbs.	347,838	3
Marble onyx and travertine		23,011	9
Mineral water	19,348,513 gals.	777,899	43
Natural gas	298,922,708 M.cu.ft.	18,585,970	(B)
Petroleum	214,776,227 bbls.	211,667,185	(B)
Platinum	1,134 oz. crude	40,669	30
Pumice and volcanic ash	17,132 tons	143,709	15
Quicksilver	8,758 flasks	671,055	63
Salt	398,249 tons	1,227,505	12
Sandstone		9,180	5
Silica (quartz) sand	77,830 tons	310,278	6
Silver	2,103,799 fine ozs.	1,629,392	E49
Slate		49,818	5
Soapstone and talc	25,643 tons	309,287	10
Soda	121,734 tons	1,412,788	4
Stone, miscellaneous	(C)	16,578,238	273
Tungsten	236 tons	210,819	3
Zinc	29,740 lbs.	1,487	C3
Unapportioned (D)		5,993,907	(D)
Total value		$327,804,268	

A There were 903 lode mines and 639 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

B There was an average of 12,191 producing wells.

C Includes macadam, crushed rock, ballast, rubble, rip rap, sand and gravel.

D Includes Barite (2), Bituminous rock (2), Bromine (2), Calcium chloride (1), Carbon dioxide (2), Diatomite (6), Dolomite (2), Iodine (2), Iron (3), Magnesite (2), Mica (3), Mineral paint (1), Potash (1), Pyrite (1), Sillimanite group (1), Tube mill pebbles (1), Sulphur (1).

E Includes more important operators, and is also included under Gold.

Distribution by counties is given in the following tabulation:

County	Value	Number o mineral products
Alameda	$2,413,115	7
Alpine	9,541	3
Amador	3,617,449	9
Butte	1,393,874	10
Calaveras	3,513,180	10
Colusa	15,483	3
Contra Costa	1,706,131	8
Del Norte	16,776	5
El Dorado	2,796,980	13
Fresno	40,245,111	17
Glenn	134,466	2
Humboldt	78,098	6
Imperial	256,941	11
Inyo	1,470,847	18
Kern	65,344,764	18
Kings	9,949,931	3
Lake	341,066	4
Lassen	66,283	5
Los Angeles	86,227,432	20
Madera	222,592	6
Marin	222,974	4
Mariposa	1,130,018	8
Mendocino	35,596	2
Merced	2,009,328	8
Modoc	32,306	4
Mono	498,851	7
Monterey	187,750	10
Napa	567,153	10
Nevada	10,322,695	8
Orange	22,132,919	13
Placer	1,554,865	14
Plumas	1,923,777	8
Riverside	4,449,170	14
Sacramento	4,254,685	9
San Benito	348,812	4
San Bernardino	15,396,166	25
San Diego	582,556	13
San Francisco	23,870	2
San Joaquin	461,064	6
San Luis Obispo	352,346	13
San Mateo	2,410,807	6
Santa Barbara	9,693,339	10
Santa Clara	675,188	11
Santa Cruz	2,103,122	9
Shasta	1,699,902	7
Sierra	787,634	5
Siskiyou	831,103	10
Solano	46,552	4
Sonoma	185,417	7
Stanislaus	691,614	9
Sutter	17,368	2
Tehama	100,403	2
Trinity	724,109	8
Tulare	209,968	11
Tuolumne	723,469	10
Ventura	17,631,880	8
Yolo	71,609	3
Yuba	2,893,823	5
Total value	$327,804,268	----------

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral

resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20806 PETRIFIED IRON WOOD.
Found on the Arizona side of the Colorado River, in Yuma County, Arizona.
Donor: Robert W. West—July 1937.

20807 PETRIFIED WOOD.
This wood was carbonized before silicification took place.
From Querida, Colorado.
Donor: Dan H. Francis—August 1937.

20808 ASBESTOS.
From 40 miles northeast of Globe, Arizona, on Highway No. 60
Donor: Arthur Enders—August 1937.

20809 FOSSILIFEROUS MARBLE.
From Siskiyou County, California.
Donor: J. B. Russell—September 1937.

20810 CHIASTOLITE (cut in thin sections and mounted).
From Dalton, Madera County, California.
Donor: W. B. Pitts—September 1937.

20811 MOLYBDENUM ORE.
The bluish lead-gray mineral is molybdenite (molybdenum sulphide) and the yellow mineral is ferrimolybdite, a hydrous ferric molybdate.
From near Palisade Creek, a tributary of the Middle Fork of the Kings River, Fresno County, California.
Donor: J. M. Hughes, U. S. Sierra National Forest—October 1937.

20812 DOLOMITE (Fluorescent).
From Almaden, Santa Clara County, California.
Exchange—October 1937.

20813 CURTISITE.
Fluorescent effect—pale green.
From Skaggs Springs, Sonoma County, California.
Donor: Leo Curtis—October 1937.

20814 NAPALITE.
Fluorescent effect—copper color.
From Skaggs Springs, Sonoma County, California.
Donor: Leo Curtis—October 1937.

20815 SCHEELITE—a high grade tungsten ore.
From near Mirage Lake, San Bernardino County, California.
Donor: Nicholas Baxter—October 1937.

LABORATORY

FRANK SANBORN, Mineral Technologist

Probably the most interesting minerals, from a scientific standpoint, are those that give off energy in the form of rays year after year without any apparent decrease in weight or other changes in physical or chemical properties. Minerals and other substances that have this ability of continuously emitting rays are said to be radio-active. The most widely known radio-active material is radium which is present in some radio-active minerals but not in all.

Radium is formed naturally from uranium through a complicated series of transformations; hence radium is found only in minerals containing uranium. Some radio-active minerals owe their radio-activity to other substances such as thorium or actinium which are radio-active, but to a much smaller degree than radium. It is possible therefore for a mineral to be radio-active and yet contain no radium. The most important uranium and radium-bearing minerals are pitchblende or uraninite, and carnotite. These two minerals are used as a source of uranium and radium, and they have very distinguishing characteristics which make them easy to identify. Pitchblende is usually black and resembles pitch, but is very heavy. On picking up a piece of it a person is reminded by its weight of a piece of lead. Carnotite is a mineral with a distinguishing canary-yellow color. By use of a simple instrument known as the electroscope, the radio-activity of these two minerals or of any other radio-active mineral can be readily detected. By use of this device all doubt as to whether a mineral is radio-active or not is quickly eliminated. Pitchblende occurs in commercial quantities in the Great Bear Lake District of northern Canada, and in the Belgian Congo. Commercial quantities of carnotite are found in Colorado and Utah.

Radio-active minerals occur in California, but to date have been found only in very small amounts. In 1922 a sample submitted from Imperial County was found to contain a very small amount of a uranium phosphate, probably the mineral autunite. The mineral allanite, a silicate of indefinite composition but usually containing thorium to which its radio-activity is probably due, occurs in Riverside County and it has been found in other parts of the state.

A small amount of pitchblende has been reported found in Calaveras County. None of these radio-active deposits or any of the others reported in the state have ever been worked for radium, uranium or thorium since they are far too small and in no way can they compare with the much richer Canadian and Belgian deposits.

LIBRARY

JOHN C. O'BRIEN, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, CALIFORNIA JOURNAL OF MINES AND GEOLOGY contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the state are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

Topographic Sheets:

Acton Quadrangle, Los Angeles Co.
Beartrap Canyon Quadrangle, Los Angeles County.
Boneyard Canyon Quadrangle, Los Angeles Co.
Bouquet Reservoir Quadrangle, Los Angeles Co.
Camp Bonita Quadrangle, Los Angeles Co.
Chileno Canyon Quadrangle, Los Angeles Co.
Crystal Lake Quadrangle, Los Angeles Co.
Dark Hole Quadrangle, Fresno Co.
Fairmont Quadrangle, Los Angeles Co.
Guijarral Hills Quadrangle, Fresno Co.
Healdsburg Quadrangle, Sonoma Co.
Holtville Quadrangle, Imperial Co.
Hughes Lake Quadrangle, Los Angeles Co.
Lake Quadrangle, Los Angeles Co.
La Verne & Evey Canyon Quadrangle, Los Angeles Co.

Liebre Quadrangle, Los Angeles Co.
Mescal Creek Quadrangle, Los Angeles Co.
Mt. Gleason Quadrangle, Los Angeles Co.
Norco Quadrangle, Los Angeles Co.
Oil Center Quadrangle, Kern Co.
Palmdale Quadrangle, Los Angeles Co.
Prado Quadrangle, Los Angeles Co.
Puente Quadrangle, Los Angeles Co.
Red Rover Quadrangle, Los Angeles Co.
Reef Ridge Quadrangle, Los Angeles Co.
Reynolds Ranch Quadrangle, Kern Co.
San Fernando Quadrangle, Los Angeles Co. Vegetation types of, So. Calif. Sheet No. 1, So. California Sheet No. 2.
Trail Canyon Quadrangle, Los Angeles Co.
Valyermo Quadrangle, Los Angeles Co.
Voilin Canyon Quadrangle, Los Angeles Co.

U. S. Department of Agriculture, Forest Service:

Map of Angeles National Forest, San Bernardino Meridian.

U. S. Bureau of Mines.

Information Circulars:

6943 Design of Small Wooden Head Frames. By W. W. Staley.
6945 Mining and Milling Methods at the Pilgrim Mine, Chloride, Arizona. By Earl F. Hastings.
6946 Recommendations of the U. S. Bureau of Mines on Certain Questions of Safety as of October 1, 1936. By Mine Safety Board.
6947 Mining & Milling Methods and Costs at the Golden Messenger Mine of the United Gold Mines Corp., York, Mont. By S. H. Lorain.
6951 Progress Report 4 on Investigation of Detachable Rock Drill Bits; printed by the Timkin Roller Bearing Co., Canton, Ohio, U. S. A., under a cooperative agreement with the U. S. Bureau of Mines. By McHenry Mosier.
6952 List of Respiratory Protective Devices Approved by the U. S. Bureau of Mines. By H. H. Schrenk.
6953 Hazards of Compressed-Air Jets for Ventilating Gassy Mines. By R. D. Currie and L. L. Naus.
6954 Dust Hazards and Their Control in Mining. By D. Harrington.
6957 Some Results of First-Aid Training of all of the Employees of a Mine or Plant. By J. J. Forbes.

Governmental, National.

U. S. Bureau of Mines:

Technical Paper No. 578, Relative Value of Gypsum and Anhydrite as additions to portland cement.

Report of Investigations:

3349 Recovery of Potash from Tailings of a Porphyry Copper Property. By G. L. Oldright, Virgil Miller, Horst Sieg, W. E. Keck and F. K. Shelton.

Bulletin 403, Asbestos.

U. S. Geological Survey:

Water Supply Paper No. 811, Part II, Pacific Slope Basins in California.
Water Supply Paper No. 796A, Methods of Locating Salt-Water Leaks in Water Wells.
Water Supply Paper No. 814, Pacific Slope Basins in Oregon and Lower Columbia River Basins.
Professional Paper No. 186-J, Additions to some Fossil Floras of the Western U. S. By Roland W. Brown.
Bulletin 887, Geophysical Abstracts 87, July-December, 1936.

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon Bureau of Mines and Geology, Corvallis.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemmologist, London.
Gold, Toronto, Canada.

Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nickel Cast Iron News, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Moscow, Idaho.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.

San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California
Western Mineral Survey, Salt Lake City, Utah
Western Sentinel, Etna Mills, California.

Books.

Land Use Programs of Public Agencies in California Organization Personnel, History and Objectives.
Gold Deposits of the World. By Wm. Harvey Emmons.
Minerals Yearbook, 1937, U. S. Dept. of the Interior.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

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EMPLOYMENT SERVICE

Following the establishment of the Division of Mines' branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist. 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.70
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.70
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	---- 1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps William Irelan, Jr.	1.25
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.60
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.00
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.55
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	$0.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.90
Mines and Mineral Resources of Plumas County, 188 pp., paper	.60
Mines and Mineral Resources of Sierra County, 144 pp., paper	.60
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.00
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.30
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.30
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.30
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.30
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.30
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.30
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.30
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California, Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.30
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.35
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.30
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.35
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.30
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.30
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.30
April, 1928, Mines and Mineral Resources of Mariposa County	.30
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.30

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	$0.30
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.35
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.35
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.35
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.35
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.30
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.35
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.35
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931. Preliminary Report of Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.35
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.35
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.30
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.35
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.35
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.65

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:	
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties	$0.90
July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts. Senate Bill 480. Navigable Waters, Assembly Bill 1543	.90
Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits	.50
April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores	.90
October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas	.50
Chapters of Report XXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties, Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation	.50
April. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits	.50
July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights	.50
October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County	.50
Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Gold Mines of Placer County, including Drag-line Dredges. Geologic Report on Borax Lake, California	.50
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**Map of Madera County, Showing Boundaries, National Forests	----
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DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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